

PART 800
WATER AND SEWER

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SECTION 801

TRENCH EXCAVATION, BACKFILLING, AND COMPACTION

801.1 DESCRIPTION

The work covered by this specification consists of all material and labor to perform all work necessary in connection with the excavation and backfilling of trenches in accordance with the plans.

Excavation, backfilling and compaction for appurtenance structures, such as manholes, inlets, vaults, valve boxes, etc., shall conform to the applicable requirements as specified for pipe trenches.

801.2 MATERIALS

Pipe Bedding:

- a) **Type 1 Pipe Bedding Material** shall be crushed rock conforming to ASTM C-33, Gradation No. 67.
- b) **Type 2 Pipe Bedding Material** shall be a sand-gravel mix conforming to KDOT Standard Specifications for Type UD-2 underdrain aggregate.
- c) **Type 3 Pipe Bedding Material** may, at the option of the Contractor, be the same the as Type 1 or Type 2; or it may be pit-run sand; or it may be select earth material which is free from stones larger than two inches in the longest dimension or trash and contains proper moisture content for compaction.
- d) **Sand** used as bedding material shall be clean washed sand with one-hundred percent (100%) passing the 3/4" sieve, not more than twenty-five percent (25%) retained on a No. 4 sieve and not more than ten percent (10%) passing the No. 200 sieve.

Excavatable Flowable Fill:

Excavatable flowable fill shall be in accordance with Section 306.

Flowable mortar fill shall be used in sewer, water, and utility trenches under the pavement or at other locations as shown on the plans, or as specified.

The mix design for flowable fill mortar shall be approved by the Engineer, and shall meet the following minimum requirements:

<u>Material</u>	<u>Proportion</u>
Cement / Fly Ash	350 lbs/cy
Fine Aggregate	2,600 lbs/cy
Air Content	15 - 20%

It is intended that the mix design produce a maximum 150 psi compressive strength at 28 days.

Cement / Fly Ash shall be in accordance with Subsection 40.

Fine Aggregate for flowable mortar shall be natural sand consisting of mineral aggregate particles. The gradation of this material shall be as follows:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4	100
200	0 - 10

801.3 PAVEMENT REMOVAL

Pavement removal shall be in accordance with Subsection 202.4 "Pavement Removal".

801.4 TRENCH EXCAVATION

General:

The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the plans, and including excavation ordered by the Engineer of compacted backfill for the purpose of making density tests on any portion of the backfill.

All excavation shall be done by Open Cut, except where necessary to tunnel under existing sewers or other underground utilities and/or locations where tunneling is expressly permitted or directed by the Engineer.

Trench Width:

Trenches for other than cast-in-place pipe shall conform to the following dimensions, unless otherwise specified in the Special Provisions, indicated on the plans and/or approved by the Engineer.

<u>Table 801-1</u>	<u>Max Width at Top of Pipe Greater Than O. D. of Barrel</u>	<u>Min Width at Springline Each Side of Pipe</u>
<u>Size of Pipe (ID)</u>		
Less than 18"	16"	6"
18" to 24" inclusive	19"	7-1/2"
27" to 39" inclusive	22"	9"
42" to 60" inclusive	1/2 O.D.	12"
Over 60"	36"	12"

Trench Grading:

Trenches shall be graded to allow for specified bedding requirements and to conform with the pipe alignment and elevation shown on the plan. The Engineer will provide offset line and grade stakes as necessary to facilitate the construction. The Contractor shall preserve all stakes and benchmarks.

Trench Stabilization:

The Contractor shall make adequate subsurface soil explorations to be satisfied as to the character of the work prior to submitting his bid.

The Engineer may direct that trench stabilization be installed when groundwater or unstable soil conditions are encountered. Trench stabilization for sanitary/storm pipe shall consist of over-excavation and placement of additional compacted type 1 pipe bedding material. Any trench stabilization required as a result of surface water entering the trench or to correct inadvertent over-depth trenching shall be installed at the Contractor's expense.

The Contractor shall install dewatering systems as necessary to keep trenches free of water. In no circumstance will pipe be laid in standing water. Dewatering systems shall remain in operation until the trench has been backfilled. The cost for this work will be included in the unit price bid per foot of pipe.

Trench Shoring:

The Contractor shall do such trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to governing laws. Approved trench boxes may be used in place of shoring.

All shoring deemed necessary to protect the excavation and to safeguard employees, shall be installed. See Section 107.

Open Trenches:

Except when approved by the Engineer, trenches shall not be opened more than two hundred feet (200') in advance of laying pipe.

Trenches across streets shall be backfilled as soon as possible after pipe laying.

Substantial steel plates with adequate trench bracing shall be used to bridge across trenches at street crossings where trench backfill and temporary patches have not been completed during regular work hours. Safe passage for pedestrians shall be provided.

Grading and Stockpiling:

The Contractor shall strip and save the top six inches (6") of topsoil in unpaved developed areas. After the sewer is installed, the topsoil will be replaced by the Contractor.

All grading in the vicinity of trench excavation shall be controlled to prevent surface water from flowing into the trenches. Any water accumulated in the trenches shall be removed by pumping or by other approved methods.

During excavation, material suitable for backfilling shall be piled in an orderly manner, a sufficient distance back from the edges of trenches, to avoid overloading and to prevent slides or cave-ins. Material unsuitable for backfilling, or excess material, shall be hauled from the job site and disposed of by the Contractor.

801.5 IMPROVED BEDDING

General:

Improved bedding shall be defined as the initial pipe backfill to a depth of twelve inches (12") above the top of the pipe. All pipe bedding shall be improved bedding, except where flowable fill is specified or required, and shall be hand placed and tamped under the haunches and around the pipe in uniform, maximum six-inch (6") lifts. The improved bedding shall be worked simultaneously on each side of the pipe to insure equal fill heights at all times. Particular care shall be taken to obtain uniform bearing along the length of pipe without causing joint damage or displacement.

All bedding shall be brought to proper moisture content and compacted to not less than ninety percent (90%) of maximum dry density as determined by AASHTO Method T99.

Sanitary/Storm Pipe:

- a) **Improved bedding for rigid pipe** shall consist of Type 1 or 2 Pipe Bedding Material under the barrel of the pipe extending up to a level equal to one-sixth ($1/6$) the outside pipe diameter. Type 3 Pipe Bedding Material shall be used from this level to a level twelve inches (12") above the top of the pipe.
- b) **Improved bedding for flexible pipe** shall consist of Type 1 or 2 Pipe Bedding Material under the barrel of the pipe extending up to a level twelve inches (12") above the top of the pipe.
- c) **Improved bedding for semi-rigid pipe** shall consist of Type 1 or 2 Pipe Bedding Material under the barrel of the pipe extending up to a level equal to one-half ($1/2$) the outside pipe diameter. Type 3 Pipe Bedding Material shall be used from this level to a level twelve inches (12") above the top of the pipe.

Waterline Pipe:

Improved bedding for waterline pipe shall consist of sand placed from six inches (6") under the barrel of the pipe extending to a level twelve inches (12") above the top of the pipe.

Improved bedding for Prestressed Concrete Steel Cylinder Pipe (PCCP) shall conform to the bedding recommended by the manufacturer, as approved by the Engineer.

801.6 BACKFILLING AND COMPACTION

General:

All trenches and excavations shall be backfilled immediately after the installation of improved bedding. Trench backfill, beginning twelve inches (12") above the top of the pipe shall be as described herein, unless shown otherwise on the plans and/or directed by the Engineer.

Trenches under existing or proposed pavement, or where shown elsewhere on the plan, shall be backfilled with Fill to an elevation of two feet (2') below the bottom of the existing or proposed pavement. The Engineer may waive the requirement for flowable fill when the distance between the top of the pipe and the bottom of the existing or proposed pavement is less than four feet (4'). Jetted sand may be used when approved by the Engineer.

Trenches not under existing or proposed pavement and having less than seven (7') of cover over the pipe shall be backfilled with excavated material mechanically compacted to a density equal to or greater than ninety percent (90%) of standard density. Such trenches with cover over the pipe equal to or greater than seven feet (7') may be either backfilled with excavated material compacted to ninety percent (90%) of standard density or consolidated by flushing and vibrating, upon approval of the Engineer.

The top two feet (2') of trenches within alley or street right-of-way shall be backfilled with excavated material mechanically compacted to a density equal to or greater than ninety-five percent (95%) of standard density. The Contractor will be required to furnish other approved backfill material suitable for mechanical compaction when laboratory tests indicate the Contractor is not able to obtain the required density by mechanical compaction of the material excavated from the trench.

Trenches to be consolidated by flushing shall be sand backfilled when the excavated material is not suitable for backfill material as determined by the Engineer. The top one foot (1') of trenches to be flushed shall be earth backfill compacted to a density equal to or greater than the existing adjacent undisturbed material. Backfill material to be flushed shall be placed in six-foot (6') maximum lifts

when the trench is within alley or street right-of-way, and in twelve-foot (12') maximum lifts when the trench is outside of alley or street right-of-way. Each lift shall be thoroughly consolidated by using water jets and vibrators. Consolidation of backfill by flushing and vibrating shall result in a final density which equals or exceeds ninety percent (90%) of the standard density. Water shall be applied so that effective settlement is obtained with a minimum amount of water. Trenches shall not be permitted to overflow. Special care must be taken during backfilling, flushing, and compacting operations to prevent pipe from floating. Water shall be introduced into the layer being flushed through a long pipe nozzle and in such a manner that the granular fill, tamped material or the previously placed layer will not be disturbed, and in no case shall the nozzle end be inserted closer than three feet (3') above the top of the pipe.

County Right-of-Way:

Unless shown otherwise on the plans and/or directed by the Engineer, backfill within County Right-of-Way shall be as follows:

The top two feet (2') shall be compacted to one hundred percent (100%) of standard density and the backfill from twelve inches (12") above the pipe to within two feet (2') of the surface shall be compacted to ninety-five percent (95%) of standard density, where the pipe is crossing a paved surface, including driveways. Jetted sand may be used when approved by the Engineer.

801.7 PAVEMENT REPLACEMENT

All pavement or driveway repair shall extend a minimum of one foot (1') beyond the edge of the trench. No.6 deformed reinforcing steel bars shall be placed across the ditch on two-foot (2') centers with the bars extending a minimum of eleven inches (11") past the edges of the trench. Two No.6 longitudinal reinforcing steel bars shall be placed parallel with the centerline of the trench for the full width of the pavement. All bar crossings shall be securely fastened using wire ties. The pavement repair shall be two inches (2") thicker than the original pavement in an area of one foot (1') beyond either side of the trench. The dimensions of pavement, curb, gutter, driveways and sidewalk shall conform to City Standards for that type of work even though those structures removed may not have originally conformed to such standards. Reconstruction of asphaltic concrete pavement shall conform to requirements in Section 405. Reconstruction of concrete pavement shall conform to requirements in Section 406.

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SECTION 802

ENCASEMENT OF WATER OR SEWER PIPE BY JACKING OR TUNNELING OPERATION

802.1 DESCRIPTION

The Contractor shall furnish all labor, material, and equipment as required to perform the jacking or tunneling operation in accordance with the plans and specifications.

In the performance of the work, the Contractor shall comply with the lawful requirements of the affected Contracting Agencies, owners of public utilities and any other facilities which might be endangered by jacking or tunneling operations.

802.2 GENERAL

The inside diameter of the liner plate or casing shall be a minimum of six inches (6") larger than the outside diameter of the bell section of the carrier pipe, unless shown otherwise on the plans or directed by the Engineer.

The approach pit for jacking or tunneling operations shall be secured to safeguard existing sub-structure and surface improvements and to protect against ground movement.

802.3 PIPE INSTALLATION BY BORING AND JACKING METHODS

Water pipe shall not be installed directly by boring or jacking methods unless approved by the Engineer.

Steel casing or sewer pipes shall be installed by boring and jacking methods where specified by the plans. Pipe to be bored and jacked shall be as specified by the plans. Steel casing for bored and jacked construction shall be steel pipe conforming to ASTM A-139 with a minimum diameter as shown on the plans. Steel shall be Grade B under railroads and Grade A on all other uses. Steel pipe shall have welded joints in accordance with AWWA C-206 and shall have minimum wall thickness as indicated in the following table:

<u>Diameter of Casing - inches</u>	Nominal Wall Thickness -- inches	
	<u>Under Railroads</u>	<u>All Other Uses</u>
12	0.282	0.188
14	0.282	0.188
16	0.282	0.188
18	0.312	0.250
20	0.344	0.281
22	0.375	0.281
24	0.406	0.281
26	0.438	0.312
28	0.469	0.312
30	0.469	0.312
32	0.500	0.344

34	0.531	0.344
36	0.531	0.344
42	0.563	0.375
48	0.563	0.375

For casing diameters larger than 48", plans shall specify minimum diameter and wall thickness to be used.

Excavation shall be completed by approved methods applicable to the materials encountered. The sewer in the area to be bored and jacked shall be completed before the construction of adjacent portions of the same sewer so minor adjustments can be made in the adjacent sewer to compensate for slight discrepancies in alignment or grade which may occur in the boring and jacking process. Boring and jacking operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. The casing or pipe shall be jacked as the boring proceeds. Boring without simultaneous jacking of the casing or pipe will not be permitted.

The steel casing or carrier pipe shall be cleaned of all debris after its installation is complete. Redwood or other approved preservative treated wood skids shall be secured to the barrel of the carrier pipe with metal bands in such a manner to support the weight of the pipe along its full barrel length on the wood skids without any of the weight supported by the pipe bell and in such a manner as required to properly position the carrier pipe to the specified elevations and alignment. The casing spacers must be located as recommended by the spacer manufacturer and approved by the Engineer. Only approved casing spacers may be used. Casing spacers may be used in lieu of treated wood skids. The casing spacers must be located as recommended by the spacer manufacturer and approved by the Engineer. Only approved casing spacers may be used. The annular space between the steel casing and the carrier pipe shall be filled with sand from end seal to end seal after the carrier pipe has been permanently placed in the casing, and approved, in such a manner such as not to disturb the alignment or grade of the carrier pipe. Excavatable flowable fill may be used on sewers when approved by the Engineer.

End seals shall be constructed on each end of the casing as shown on the plan or directed by the Engineer.

The unit price named in the Proposal for steel casing bored and jacked shall cover all costs for completion of this item including excavation, steel casing, sand fill, end seals, skids, bands, fittings, backfill and compaction of backfill. Sewer pipe installed in the steel casing will be paid for separately at the unit price stated in the Proposal.

802.4 TUNNEL LINER INSTALLATION

Before starting operations, the Contractor shall submit, in accordance with Subsection 105.3, detailed shop drawings of the liner plate, method of installing liner plates, tunnel dimensions, carrier pipe installation method, and the bracing to prevent carrier pipe shifting and flotation.

Tunnel liner plates shall be used where specified by the plans. The cross section of the tunnel shall be circular and of the size indicated. Alternate sizes and shapes may be submitted for approval subject to it being best suited for proposed method of excavation and lining, the clear cross-sectional area shall not be less than the clear area of the circular section specified by the plans, and the invert shall be at a grade consistent with adjoining open cut construction.

Excavation of the tunnel shall be by approved methods consistent with the materials encountered. The sewer in the area to be tunneled shall be completed before the construction of adjacent portions of the same sewer so minor adjustments can be made in the adjacent sewer to compensate for slight discrepancies in alignment or grade which may occur in the tunnel construction. The liner plates shall be installed and assembled as the tunnel is excavated. The liner plates shall be installed such that the longitudinal joints in adjacent rings will be staggered. Longitudinal joints and circumferential joints shall all be bolted joints. The excavation shall be accomplished in such a way that will prevent disturbing overlying material. Care shall be taken to maintain alignment, grade and circular shape of the tunnel when the liner plates are installed. All voids between liner plates and surrounding earth shall be filled with grout forced in under pressure. Grouting holes shall be plugged as soon as the voids are filled in that section to prevent the grout from flowing back out.

The lining shall be cleaned of all debris after its installation is complete and all leaks which allow flowing or seeping water into the tunnel shall be plugged. Redwood or other approved preservative treated wood skids shall be secured to the barrel of the carrier pipe with metal bands in such a manner to support the weight of the pipe along its full barrel length on the wood skids without any of the weight supported by the pipe bell and in such manner as required to properly position the carrier pipe to the specified elevations and alignment. The annular space between the carrier pipe and the tunnel liner shall be filled with sand from end seal to end seal after the carrier pipe has been permanently placed in the tunnel, tested and approved, in such a manner such as not to disturb the alignment or grade of the carrier pipe. Excavatable flowable fill may be used on sewers approved by the Engineer.

End seals shall be constructed on each end of the tunnel as shown on the plan or directed by the Engineer.

The unit price named in the Proposal shall cover all costs for completion of this item including excavation, liner plates, sand fill, end seals, grouting, skids, bands, fittings, backfill and compaction of backfill. Carrier pipe installed in the tunnel will be paid for separately at the unit price stated in the Proposal.

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SECTION 803

WATER LINE CONSTRUCTION

803.1 DESCRIPTION

The construction of all water lines shall conform to applicable standard specifications and details, except as otherwise required on the plans or as modified in the special provisions.

803.2 GENERAL

All pipe shall be delivered, handled and installed in accordance with the manufacturer recommendations and/or applicable provisions of AWWA standards for installation of the various types of water mains specified, insofar as such recommendations and provisions are not in variance with the standard specifications and details.

Where water lines are to be constructed in new subdivisions or in conjunction with street repaving projects, the streets shall be pre-graded to within six inches (6) of the new street subgrade prior to trenching. Cost to be considered subsidiary to pipe installation.

803.3 MATERIALS

General:

Used pipe shall not be allowed for construction of waterline projects.

Salvaged material shall be returned to the Wichita Water Department Material Yard at 1701 Sim Park Drive.

Unless otherwise shown on the plans, all materials for waterlines shall be of the type shown for the size pipe specified:

- a) The 2-inch and 2 ½-inch (2" and 2 ½") diameter pipe shall be Polyvinyl Chloride (PVC).
- b) The 4-inch through 12-inch (4" through 12") diameter pipe shall be either Polyvinyl Chloride (PVC) or Ductile Iron Cement Lined (DICL).
- c) The 16-inch (16") and larger pipe shall be Ductile Iron Cement Lined (DICL) pipe, Polyvinyl Chloride (PVC) pipe or Prestressed Concrete Steel Cylinder pipe (PCCP).

"A pipe laying schedule shall be required for all PCCP pipe and for DICL pipe twenty inches (20") or greater in diameter. Six (6) sets of the pipe laying schedule shall be provided to the Engineer for review and approval prior to ordering material. The laying schedule shall indicate all significant items located along the pipe, including fittings, bends, outlets, etc., and their proposed stationing. After the laying schedule has been approved, the pipe shall be ordered and constructed. Pipe not meeting the requirements of the laying schedule shall not be accepted for the project."

- d) The fittings to be used with water line installation include: PVC fittings for 2 ½-inch (2 ½") or smaller pipe; compact ductile iron fittings or cast iron fittings for 4-inch (4") and larger pipe; and DICL or PCCP fittings with PCCP pipe, as designed for the project. All fittings must meet the pressure rating of the pipe used for the project.

Polyethylene Wrap:

The polywrap shall be of virgin polyethylene, not less than 8 mils in thickness, formed into tubes or sheets as required. Material shall be pigmented with 2 to 2-1/2 percent (2 - 2 ½%) of well-dispersed carbon black with stabilizers. In the event 8 mil polywrap is not available, additional layers of lighter material may be used as allowed by the Engineer. The lighter material shall in no case be thinner than 6 mils.

The polywrap shall be secured with two-inch (2") wide pressure sensitive plastic tape not less than 10 mils thick. The tape shall be Scotchrap No. 50, Polyken No. 900, Tapecoat CT, Johns-Manville No. V-10 Trantex, or approved equal.

Polytube shall be used along lengths of pipe and be sized in accordance with pipe manufacturer recommendations.

Water Pipe/Fittings:

- a) **Ductile Iron Cement Lined Pipe (DICL)** - Ductile iron cement lined pipe shall be constructed in accordance with all requirements of ANSI A 21.51 (AWWA C151 or the latest revision).

All ductile iron cement lined pipe shall meet the requirements of Pressure Class 350 pipe for sizes 12" and smaller, and pressure Class 250 for all pipe 16" and larger, unless otherwise indicated by the plans. The exterior of the pipe shall be coated with a bituminous coating of coal-tar or asphalt base at least one mil thick. The interior of the pipe shall have a cement lining in accordance with ANSI A21.4 (AWWA C104) with a Bituminous Seal-Coat. Joints shall be slip type with single rubber gasket in accordance with ANSI A21.11 (AWWA C111). All DICL pipe and fittings shall be wrapped in accordance with Subsection 803.6.

Ductile iron cement lined fittings shall conform to ANSI/AWWA C110. The fittings shall have standard mechanical joint ends conforming to ANSI A21.11 (AWWA C111). The fittings shall have interior and exterior coatings as specified above for DICL pipe.

- b) **Polyvinyl Chloride Pipe (PVC)** -

2 ½" or Smaller PVC Pipe: The polyvinyl chloride pipe shall be made in accordance with and shall conform to ASTM 1784, Type 1, Grade 1 for PVC compounds; ASTM 2241 for PVC pipe; commercial standard CS-256 for PVC pipe; and NSF Standard Number 14. The PVC pipe shall be class 200, suited for working pressure of 200 psi at 73 degrees F. Joints for the pipe shall be push-on using rubber ringed couplings conforming to ASTM D-1869 requirements.

4" or Larger PVC Pipe: The polyvinyl chloride pipe shall be made in accordance with and conforming to AWWA Standard Specifications for polyvinyl chloride pipe, C-900 or C-905 depending on pipe diameter, or the latest revisions thereof. The pipe shall be DR-18, unless otherwise shown on the plans, and be cast iron outside diameter. The pipe shall use couplings or have bell ends manufactured integral to the pipe. Couplings shall be push-on using rubber rings. The rings shall consist of properly vulcanized rubber compounds, free from porosity. All surfaces shall be smooth and free from pitting, blisters, air checks and other imperfections. The thickness shall be uniform throughout. Upon completion of the project, the Contractor shall provide, at no additional expense, six (6) couplings for each size pipe used on the project.

c) Prestressed Concrete Steel Cylinder Pipe (PCCP) -

Prestressed concrete steel cylinder pipe shall be as set forth by AWWA C301 or the latest revision thereof, for prestressed concrete pressure pipe, steel cylinder type.

Prestressed steel cylinder pipe shall be designed for 150 psi working pressure and shall be properly prestressed to accommodate the trench backfill loads at the depths shown on the drawings.

All specials and fittings shall conform to requirements of AWWA C301 and shall be designed and fabricated to accommodate pressure and backfill load stresses equal to or greater than the connecting piping.

Each length of pipe and all specials and fittings shall be marked to show the proper location in the line. Schedules and drawings shall be submitted to the Engineer for approval prior to manufacture or shipment as required in section 1.5 of AWWA C301.

Installation of PCCP, shall conform to both the requirements of the project specifications and the recommendations by the manufacturer as approved by the Engineer. Joint grouting will be required depending on pipe diameter and as recommended by the manufacturer, as approved by the Engineer.

d) High Density Polyethylene Pipe (HDPE) -

High Density Polyethylene Pipe shall conform to AWWA Specification C906-90, or the latest revision thereof. All HDPE pipe shall be DR-11, and have a working pressure rating of 160 psi, unless otherwise stated on the plans. As the pipe inside diameter (I.D.) is critical to the project, the HDPE pipe to be used, shall have an I.D. equivalent to the pipe size specified by the project plans. Due to the pipe wall thickness of HDPE pipe, it may be necessary to upsize the HDPE pipe to have an equivalent I.D. of the type of pipe material shown on the plans. Such increase of HDPE pipe sizing shall be considered subsidiary to providing equivalent pipe and not be bid or paid for separately.

All fittings to be used with HDPE pipe shall be typical cast iron or ductile iron mechanical joint fittings, adapters shall be used as necessary to connect to such fittings. Harvey connectors are approved for use with HDPE pipe for making connections to cast iron or ductile iron fittings. The cost of such adapters shall be considered subsidiary to the use of HDPE pipe and not be bid or paid for separately. HDPE fittings have not been approved for use on water projects.

All HDPE pipe shall be joined using butt fusion. The Contractor shall provide the appropriate butt fusion equipment to join the pipe. Joints shall conform to the manufacturers recommendations and be water tight at the test pressure. The bead which forms during the fusion process shall be uniform, indicating a proper fusion. Joints not meeting these requirements shall be cut out and remade. Cost of joint fusion shall be considered subsidiary to the pipe installation and not bid or paid for separately.

Pipe bedding shall conform to the requirements for other types of pipe material, including sand backfilling and compaction as specified by these plans. If installed by directional drilling, the pipe manufacturer recommendations shall be followed as approved by the Construction Engineer for the City of Wichita.

Installation of HDPE pipe shall be by methods approved by the Construction Engineer. Methods other than approved shall not be allowed. Any installation of HDPE pipe by methods

which are not approved shall be removed and reinstalled at the expense of the Contractor.

Water Valves:

- a) **General** - Valves for water line projects shall include Mechanical Joint Gate Valves, Mechanical Joint Butterfly Valves, and Flanged Valves as required by the water line project. All valve installations shall include the installation of a valve box.
- b) **Mechanical Joint Gate Valves** - Gate valves shall be used on water lines smaller than 12-inch (12"). The valves shall be double disc gate or resilient seat wedge type gate, with non-rising stem, and shall conform to AWWA Standard Specification C500-80 and C509-80, or the latest revision thereof.

Exterior surface of the valve is to be epoxy coated. The coating shall be 8 mils thick and of an approved epoxy. Gate valves shall open left, shall have all bronze disc assemblies, and all bronze internal working parts, or shall have an approved epoxy coating to provide a corrosion resistant barrier between the base metal and the surroundings. The coating shall be factory applied using a process consisting of grit blasting and chemical cleaning to provide the best surface for fusion-bonding and heat curing, and shall be holiday free with a minimum thickness of 8-mils. Valves shall also have a 2-inch square operating nut, "O" ring seals, and mechanical joint ends with Corten material mechanical joint bolts and nuts or approved equal. Resilient seat wedge-type gate valves shall have a replaceable internally reinforced specially contoured molded rubber disc seat ring attached to the face of the disc with self-locking stainless steel screws or shall consist of a gate with a bonded elastomer seat which in the closed position, is fully encapsulated and effects a bubble-tight seal across the disc at a full differential of 200 psi. The stem and stem nut shall be of all bronze material. All gate valves provided shall have a history of at least three years service. All valves supplied under these specifications shall conform to a minimum working pressure of 175 psi and a test pressure of 300 psi.

- c) **Mechanical Joint Butterfly Valves** - Mechanical joint butterfly valves shall be used for pipe 12" and larger, unless otherwise directed or approved by the Engineer or the project plans. The valve and related equipment shall consist of tight closing rubber seat butterfly valves, Class 150, and shall be designed for use as high pressure line valves for use in the distribution system of the Wichita Water Department. Except as modified or supplemented herein, all valves shall be in accordance with AWWA Standard for Rubber-Seated Butterfly Valves, C-504-80, or the latest revision thereof.
- d) **Valve Description** - The valves shall be designed for an operating pressure of 150 psi. The valve shall give bubble-tight shutoff against a pressure of 150 psi, and the body shall be capable of withstanding a hydrostatic test pressure of 300 psi. All valves shall be satisfactory for throttling application and suitable for operation after long periods in a static position. The outside diameter of the valve body of wafer type valves, shall be such that the pipeline bolts accurately "center up" the valve in relation to pipe flanges. The valve shall be such as to provide for full opening of the disc in a pipeline of the same nominal diameter as the valve. The pipeline shall consist of cement lined cast iron pipe (or fittings) made in conformance with ASA A21.4 - 1953, A21.6 - 1953, A21.8 - 1953 or the latest revisions thereof, or pipeline of equal inside diameter. The port diameter of each valve shall not be more than 1" less than the nominal valve diameter.

- e) **Valve Bodies and Coatings** - Valve bodies shall have mechanical joint ends with gaskets, follower rings, T-head bolts made of Corten material or approved equal, as designated by ASA A21.11. The body material shall be close-grained cast iron, complying with Specification ASTM A28-48 Class 40, or ASTM A126, Class B, or the latest revisions thereof. The interior of the water way of the valve body, including any area in contact with water flow, must be epoxy coated with either AL-CLAD or Mueller HP or an approved equal.

The interior of the valve body shall be fully epoxy coated with either AL-CLAD, or Mueller HP, or an approved equal if the rubber valve seat is mounted on the valve disc. If the rubber valve seat is mounted on the valve body, then an approved non-epoxy coating will be allowed as approved by the Engineer and the Wichita Water and Sewer Department.

- f) **Valve Disc** - The valve disc shall be constructed of a cast or fabricated design with no external ribs transverse to the flow. The thickness of the disc through the center hub section of the valve disc shall be 1 3/4 to 2 1/4 times the shaft diameter to ensure structural strength. The disc shall be designed for 125 lb. shutoff with a stress less than 1/5th of the ultimate strength of the material. The disc shall be Ni-Resist, Type 1, cast bronze meeting ASTM B-143-1A of B61, or cast iron with AL-CLAD epoxy coating as provided by Dresser Manufacturing, Mueller HP epoxy coating as provided by the Mueller company, or any other coating which is approved by the Engineer and the Wichita Water and Sewer Department. All coatings shall be suitable for potable water service, and factory applied using a process consisting of grit blasting and chemical cleaning to provide the best surface for fusion-bonding and heat curing, and have a minimum thickness of 8 mils.
- g) **Valve Shaft** - The valve shaft shall be not less than the minimum diameter listed for valves in Table 4 of AWWA Specification C-504-80, or the latest revision thereof. The valve shaft material shall be one of the following: (a) Stainless steel 18-8, type 302, 303, 304, 316, or Monel; (b) Steel - if sealed from contact with internal liquids.
- h) **Valve Seat** - The valve seat shall be applied to either the valve body or the valve disc. The valve seat design shall be such that under a prolonged pressure test at 150 psi differential, the seat shall not bulge or deform or show any signs of water leakage. Any signs of such design deficiency shall be cause for rejection of the valve. Valve seats shall be made of Hycar, Buna N, or approved equal. Clamps, screws, and other appurtenances used for securing the rubber seat shall be stainless steel 18-8, Type 302, 303, 304, 316, 317, or approved equal.
- i) **Operators** - Operators for butterfly valves shall be in accordance with AWWA Specifications C-504-80, or the latest revisions thereof. The operators shall be direct bury type. The operators shall be as manufactured by Henry Pratt Company, Philadelphia Gear Corporation, Dresser Mfg., or approved equal, and shall be in accordance with specified requirements.

All working parts within the operator shall be completely bathed in an oil or suitable grease for lifetime operation. The manufacturer shall state the type of grease used in the operator. The input shaft shall be furnished with a 2-inch (2") square AWWA operating nut which shall turn clockwise to close the valve.

Fire Hydrants:

- a) **General** - The fire hydrants supplied under these specifications shall meet in every way the AWWA and New England Water Works Association Standard Specifications for Fire Hydrants for Ordinary Water Works Service, AWWA C502-54 or the latest revision thereof, except as modified herein. Direct reference to the above AWWA Specification is made by Section number in most instances.

- b) Traffic Type Fire Hydrant** - The fire hydrants used in the City of Wichita water system shall be of the traffic accident type, so that in the event of a traffic accident, the barrel will not become broken, nor the main operating stem become broken or bent. Only the safety flange or safety breaker bolts joining the upper and lower barrel sections can be damaged in the event of a traffic accident, which parts shall be easily and quickly replaceable.
- c) Fire Hydrant Requirements** - The fire hydrant shall meet the following requirements:
1. Shutoff shall be with pressure by compression.
 2. The inlet connection shall be 6" mechanical joint. Required glands, gaskets, bolts and nuts required shall be supplied with the fire hydrant and tee head bolts and nuts shall be of Corten material, or approved equal.
 3. Provisions shall be made for lengthening the hydrant without the necessity of digging.
 4. All working parts of the valve shall be removable through the top of the hydrant without the necessity of digging. Removal of parts shall be accomplished with the use of a small hydrant hand tool.
 5. All parts entering into the manufacture of the fire hydrants shall be interchangeable.
 6. The top of the hydrant shall be so constructed that the operating threads are immersed in a sealed oil or grease reservoir. "O" ring seals shall be used to prevent water and oil leakage. The stem shall be bronze lined where it passes through the "O" rings. The operating nut shall be provided with seal or shield.
 7. The interior of the shoe shall be coated with a cement mortar lining in accordance with AWWA C-104-53, or the latest revision thereof, or with a catalyst cured epoxy having a minimum thickness of 10 mils.
- d) Fire Hydrant Valve** - The fire hydrant valve shall meet the following requirements:
1. The main valve assembly shall be seated in a sub-seat of all bronze material so as to provide bronze to bronze engagement of the valve seat ring and to provide a drainage channel of non-ferrous material.
 2. The valve assembly, including the lower valve plate, shall be bronze or stainless steel. The lower stem, that is that portion below the lower valve plate, shall be completely enclosed with bronze cap nut or nuts.
 3. Valve facing - The main valve shall be faced with balata, hycar rubber, or approved equal.
 4. The fire hydrant main valves shall move from full closed to full open in not less than 12 complete turns and not more than 18 complete turns of the operating nut.
 5. Operating mechanism - Any spring assembly, between the stem and the main valve, used by the manufacturer to facilitate operations, shall be composed of either bronze or stainless steel.
 6. The fire hydrant shall open left (counter clockwise).
 7. The hydrant shall have two drain valves for automatic draining of the barrel when the main valve is closed. Exceptions to this requirement may be granted on an individual hydrant model basis as approved by the Wichita Water Department.
 8. The main valve shall be designed to provide for flushing at the drain valves during the first four turns of opening the main valve.
 9. The operating nut shall be a 1 ½ inch pentagon to match operating nuts on hydrants now in the system.

- e) **Nozzles** - The fire hydrant shall have the following:
1. Two 2 ½ inch nominal nozzles with 2 ½ inch national standard thread.
 2. One 4 inch nominal nozzle, dimensioned as follows:

Major diameter	4.962 (+0,-0.040)
Pitch diameter	4.800 (+0,-0.020)
Minor diameter	4.612
Height	0.350
Pitch	0.250
Inside diameter	4.000
Threads per inch	4
Front undercut	1/8

 "Steamer Nozzle Wichita Thread"
 3. The threads provided shall be required to match threads now in use with other fire hydrants now in use in the City of Wichita.
 4. The nozzles shall be joined to the barrel by using a threaded type joint.
 5. Nozzle cap chains shall not be included.
- f) **Fire Hydrant Materials** - The materials used in the manufacturing of the fire hydrant shall be as follows:
1. **Cast Iron** - All iron castings shall be made from a superior quality iron and of even grain and shall possess a tensile strength of not less than 32,000 pounds per square inch.
 2. **Bolts and Nuts** - Flange bolts and nuts shall be of Everdur, stainless steel, or Corten for that type of fire hydrant employing drainage between flanges of the shoe and barrel.
 3. **Packing** - Stuffing box packing shall have "O" ring seals for upper stem.
 4. **Gaskets** - Gasket material shall be rubber composition.
 5. **Epoxy Coating** - The epoxy coating shall be applied to the interior of the hydrant as follows. The casting shall be grit or sand blasted to bare metal, blown free of dust, and cured by heating to 135 degrees F. The coating shall be applied in a dust free area with a minimum of three (3) applications of equal thickness. After curing, the coating shall be tested with a holiday detector using 20,000 volts potential and shall be free from holidays.
- g) **Fire Hydrant Color** - The fire hydrant shall be painted. The nozzles and bonnet of the hydrant shall be painted red, all other parts above ground shall be aluminum.
- h) **Approved Fire Hydrants** - The fire hydrants listed below may be used on City of Wichita water projects:
- American-Darling Mark 73
 - Clow Medallion
 - Kennedy K81A
 - M & H 929
 - Mueller 107
 - Mueller Super Centurion 200
 - U.S. Pipe Metropolitan 5 1/4"

The Wichita Water Department may accept other hydrants if they have received approval prior to solicitation of bids. All fire hydrants used for City of Wichita water projects shall use a 4 ½" or 5 1/4" valve opening.

Water Service Materials:

- a) **General** - Service materials shall include corporation stops, service saddles, plastic or copper service tubing, unions and couplings, copper meter setters, meter boxes, and meter rings and lids. All services 1" or smaller shall use 1" service material and adapters as necessary to install the meter or connect to the property side service line. Material in this specification is for 1" services, larger service material must be approved by the Engineer and the Wichita Water and Sewer Department prior to installation.
- b) **Corporation Stops** - All corporation stops used for installation of services shall be 1 inch unless directed otherwise by the Engineer or indicated by the project plans. The corporation stops shall have AWWA standard inlet threads. The corporation outlet shall be compression type for copper tubing or copper tubing size polyethylene plastic tubing. Each corporation stop shall be furnished with a stainless steel insert for style 3406 polyethylene plastic tubing, copper tubing size O.D.

All corporation stops shall be Ford F1000, Hays 5200, Mueller H-15008, or approved equal.

- c) **Service Saddles** - Service saddles are required on all service taps. All service saddles shall be bronze with silicon bronze straps and bronze nuts, or 18-8 stainless steel and shall be Baker, Jones, McDonald, Mueller, Smith-Blair, Cascade, or approved equal.
- d) **Service Tubing** - Plastic tubing shall be polyethylene style 3406, 3408, polybutylene class 250, or approved equal, shall have ultra high molecular weight and shall be furnished in copper tubing size, unless otherwise specified. ProCare, ClearCor or Yardley brand polyethylene pipe are not acceptable.

Plastic tubing shall have a working pressure of 160 psi with a minimum burst pressure of 630 psi at 23 degrees C. Plastic tubing shall meet or exceed the requirements of ASTM D2737-SDR9, and must be N.S.F. approved.

Copper tubing shall conform to AWWA specifications 7-S-CR and must be manufactured within the continental limits of the United States.

All copper tubing shall be 1" type K, soft copper tubing.

- e) **Unions and Couplings** - Copper flange fitting ends shall be compression type and each end shall be furnished with stainless steel inserts for style 3306 polyethylene tubing. Threads for 1" unions and couplings shall be AWWA threads.

All unions and couplings shall conform to the sizes, ends and manufacturers listed or approved equal:

One-inch (1") unions, 3 part copper compression to copper compression; Hays 5615, Ford C44-44, Mueller 15403.

One-inch (1") couplings, copper compression to outside I.P.T.; Hays 5600; Ford C84-44, Mueller H-15451.

- f) **Copper Meter Setters** - All meter setters for installation of water services shall be 1", unless larger setters are required. Meter yokes shall be furnished with Mueller saddle nuts and with plain stop. Inlet and outlet connection shall be compression type fitting for copper tubing or copper tubing size polyethylene style 3406. Meter yokes shall be furnished with stainless steel insert for each fitting.

One inch (1") Copper Meter yokes shall be Ford V84, Hays 5615, Mueller H1408 or approved equal.

- g) **Meter Boxes** - Meter boxes shall be installed for all water services that are 1" or smaller. The meter box shall be unslotted, 24" in height, and be 21" in diameter for a 1" service. The meter box may be constructed of PVC or metal.

1. **PVC Meter Boxes** - The boxes shall be made of Class 12454 polyvinyl chloride which conforms to the current ASTM D1784 standard, formed into a seamless tube. The 21" diameter box shall have a minimum inside diameter of 21.00", and a minimum wall thickness of 0.432". The ends of the boxes must be smooth and even. All surfaces of the boxes must be white in color.

2. **Steel Boxes** - The meter boxes shall be constructed of 24 gauge galvanized steel which meets the current ASTM A-527 standard, formed by spirally winding the steel into a tube that is mechanically locked together by a 4-ply lockseam. A factory coating of white polyvinyl shall be applied with a 4 mil coating on the outside and a 1 mil coating on the inside. The boxes shall have a factory-made protective edge on each end.

Cost of meter boxes shall be considered subsidiary to the service installation bid item and not be bid or paid for separately.

- h) **Meter Rings and Lids** - Meter Rings and Lids shall be cast of good gray cast iron free from impurities and foreign bodies insofar as is customary in the industry. The rings and lids shall be painted on all surfaces with an asphaltic base paint or approved equal.

The meter rings and lids shall be: Ford C32, Ford C4 , or Wichita Water Department pattern as per the detail drawing.

- i) **Meter Coupling Plugs** - Inlet and outlet meter coupling nuts on the meter yokes are to be plugged with PVC plugs. The 1" meter yokes use 1 1/4" I.P.T. plugs.

Couplings, Gaskets, and Flanges:

- a) **Couplings:** The couplings used to join pipe of the same type shall be a mechanical joint sleeve (long) or a coupling manufactured for the pipe. The couplings used to join a pipe of one type to pipe of another type may be a Smith-Blair, or Dresser style coupling, or an approved equal. Couplings manufactured by the pipe manufacturer for use with their pipe, such as PVC collars or couplers may be used as approved by the Engineer. Cost of joint collars or couplers shall be subsidiary to the pipe installation and not bid or paid for separately.

- b) **Bolts and Nuts:** The bolts and nuts to be used with ductile iron fittings shall be tee head and made of Corten, USalloy or approved equal and be sized 1/8" smaller than the bolt hole. They shall be manufactured from low alloy, high-strength steel bar stock complying with the following requirements:

Physical Properties

1. Yield strength	45,000 p.s.i. minimum
2. Tensile strength	65,000 p.s.i. minimum
3. Elongation in two inches	20% minimum

Chemical Composition

1. Carbon, Max.	0.20%
2. Phosphorus, Max.	0.15%
3. Sulphur, Max.	0.05%
4. Silicon, Max.	0.75%
5. Manganese	0.20/1.25%
6. Copper	0.20/1.00%
7. Nickel	0.25/1.10%
8. Chromium, Max.	1.25%
9. Molybdenum, Max.	0.40%

Bolts and nuts shall be made from the same proprietary material. The mechanical joints, flanges, and other locations where the bolts and nuts are used, shall be wrapped with 8 mil polywrap to protect them from corrosion. Cost of bolts and nuts shall be considered subsidiary to the fitting for which they will be used and not bid or paid for separately.

- c) **Gaskets:** Where flanged fittings are used, gaskets shall be used. All gaskets for use with pipelines or flanged valves shall be one piece, full-faced, and made from one-ply cloth inserted SBR rubber material. For flanges 20-inches (20") and smaller, the gasket thickness shall be 1/16-inch (1/16") material, for flanges larger than 20 inches (20"), the gasket shall be 1/8-inch (1/8") material. Inspection of gasket material prior to installation will be required. Cost of gaskets shall be considered subsidiary to the installation of the fitting for which it is required and not bid or paid for separately.
- d) **Flanges:** Cast iron flanges shall conform to AWWA C-110 as to material, diameter, thickness, drilling, etc. Steel flanges shall be ring or hub type and shall conform to AWWA C-207, Class D. All flanges shall be drilled to AWWA C-110, except that bolt holes shall be 1/8-inch (1/8") larger than the bolts for the size flange. Bolts for flanges shall be as specified above and all flanges shall have flat faces. Where flanges are required, cost of such flanges shall be considered subsidiary to the fitting or pipe on which it used.

803.4 SEPARATION OF POTABLE WATER MAINS FROM SANITARY SEWERS AND POLLUTION SOURCES

Separation of Water Mains and Sewers:

- a) **Gravity/pressure sanitary sewers** - When potable water pipes and sanitary sewers are laid parallel to each other, the horizontal distance between them shall be not less than 10 feet. The distance shall be measured from edge to edge. The laying of water pipes and sanitary sewers shall be in separate trenches with undisturbed earth between them. In cases where it is not practical to maintain a 10-foot separation, equivalent protection shall be required. Reinforced concrete encasement of the sanitary sewer is one such protective measure that

may be used.

When a water pipe and a sanitary sewer cross and the sewer is 2 feet or more (clear space) below the water pipe, no special requirements or limitations are provided herein. At all other crossings, the sanitary sewer is to be constructed of Ductile Iron PVC, or Reinforced Concrete pipe, meeting the requirements specified in Subsection 804.2, and pressure tested to assure water tightness pursuant to Chapter VI of the KDHE Minimum Standard of Design of Water Pollution Control Facilities.

Joints in the sewer pipe shall be located as far as practical from the intersected water main. A distance of 10 feet is to be maintained as the distance of a sewer joint to the water line.

Where a water main is laid across or through an area where there is an existing sanitary sewer, which is not constructed of one of the above specified materials, and is two feet (2') or less below the water pipe, the existing sanitary sewer shall be encased with reinforced concrete with a minimum of six to eight inches (6" to 8") thickness for a ten-foot (10') distance on each side of the crossing or the crossed section of sewer replaced to meet the above specified construction requirements. If the water pipe is below the sanitary sewer, regardless of clear space, the sanitary sewer shall be reinforced concrete encased for a distance of ten feet (10') each way from the water line crossing.

- b) **Sewer connections** - There are to be no physical connections between any parts of the potable water system with building sewers, sanitary sewers, or wastewater treatment facilities, by means of which it would be possible for sewage, even under exceptional circumstances, to reach the wells, storage reservoirs, or distribution systems.
- c) **Sewer manholes** - No water pipe shall pass through or come in contact with any part of a sewer manhole.
- d) **Storm Sewers** - The separation distance between a storm sewer (which is not a combined storm/sanitary sewer) and a water main should be based on geotechnical considerations. Required separation distances between water mains and combined storm/sanitary sewers are equivalent to those for water mains and gravity sanitary sewers.
- e) **Drains** - Underground drains from fire hydrants or valve pits should not be directly connected to sanitary or storm drains.

Separation of Water Mains and Other Pollution Sources:

It is of the utmost importance that potable water lines be protected from any source of pollution. The following shall pertain to instances where septic tanks, absorption fields, waste stabilization ponds, feedlots, or other sources of pollution are encountered.

- a) A minimum distance of 25 ft (7.6 m) shall be maintained between all potable water lines and all septic tanks or waste stabilization ponds.
- b) Under no circumstances shall a water line extend through a septic tank absorption field or feedlot. All water lines shall be located a minimum of 25 ft (7.6 m) from the farthest known extent of any sewage contamination. Under no condition will it be considered that encasement of the water main through an area of real or potential pollution would provide the protection needed to the water supply.

Cross Connections:

There shall be no physical connection between the public water supply system and any pipes, pumps, hydrants, tanks, or non-potable water supplies whereby unsafe water or other contaminating materials may be discharged or drawn into the system. KDHE does not approve the interconnection of rural water district lines and individual or independent water supply sources such as home wells. Neither steam condensation nor cooling from engine jacket or other heat exchange devices shall be returned to the potable water supply.

803.5 CONSTRUCTION METHODS

All water mains shall have the minimum cover as shown below, unless shown otherwise on the project plans:

- a) 42" of cover for 8" pipe and smaller
- b) 48" of cover for 12" and 16" pipe
- c) 60" of cover for pipe 20" and larger

The cover is measured from the top of pipe to the proposed finish grade or proposed top of curb.

No water pipe shall be deflected, either vertically or horizontally. Deflections may be made only at couplings, joints, or fittings. Allowable deflections for the City of Wichita are shown on project plans. Under no circumstance shall deflections at joints or couplings exceed that recommended by the manufacturer.

Every precaution shall be taken to prevent foreign matter from entering the pipe that is being laid or has been placed in the line. When pipe laying is not in progress, the open ends of the pipe shall be closed with a water tight plug or by other means approved by the Engineer.

Except as otherwise required by this specification, by the special provisions, or by the Engineer, trench excavation, backfill, and compaction shall be in accordance with the requirements of Section 801. Backfilling may commence as soon as approved by the Engineer, subject to testing.

All corporation stops used for testing and chlorination shall be left in the pipe line with the stop closed and all connecting pipe removed.

Two inch (2") blowoff assemblies shall be installed at the end of each main to clear the line, unless otherwise shown on the project plans. Fire hydrants may also be used to flush the mains. The blowoff assembly detail is shown on the standard water detail sheet for the project.

803.6 POLYETHYLENE CORROSION PROTECTION**General:**

Where ductile iron pipe, ductile iron or cast iron fittings, valves, fire hydrants, or other metallic items are installed as part of the water line project, such items shall be wrapped with 8-mil polyethylene wrap (polywrap) to prevent corrosion. The polywrap shall be continuous, securely taped, and provide a continuous barrier between the pipe and surrounding bedding and backfill. Installation of polywrap shall be considered subsidiary to pipe installation.

Polytube shall be used along lengths of pipe and be sized in accordance with pipe manufacturer recommendations.

Materials:

Material requirements for Polyethylene wrap and securing tape are provided in Subsection 803.3.

Installation:

The polyethylene tubing shall be cut into lengths approximately two feet longer than the pipe sections. With the pipe suspended from the center, the tube shall be slipped over the spigot end and bunched up between the point of support and the spigot end. After the pipe is installed into the bell of the adjacent pipe, the pipe shall be lowered to the trench bottom and the supporting sling removed from the center of the pipe. The pipe shall then be raised at the bell end enough to allow the polytube tube to be slipped along the full length of the barrel with enough left at each end to overlap the adjoining pipe about one foot. A shallow bell hole must be made at each joint to facilitate installation of the polywrap. The bunched up polywrap from the preceding length of pipe shall be slipped over the end of the new length of pipe, and secured in place with one circumferential turn of tape plus enough overlap to assure firm adhesion. All lengths of polywrap are to be secured together with the approved tape. Rips or punctures of the wrap are to be repaired using wrap material secured with tape. Bends and reducers shall be wrapped using polytube.

Valves, tees, crosses, fire hydrants, and outlets, shall be wrapped with flat sheets of the same polywrap material. The sheets shall be passed under valves and brought up around the body to the stem. Edges shall be brought together, folded twice and secured with the approved adhesive tape.

803.7 VALVES

Valves shall be installed in accordance with AWWA C-600 or AWWA C-603, modified as follows:

All tapping sleeves, gate valves, butterfly valves, air release and vacuum valves, and corporation stops shall be in accordance with Subsection 803.3.

All two-inch (2") and two and one-half inch (2-1/2") valves used shall be IPT gate valves as manufactured by Clow or Mueller. Valves which are to be used on the project that are 8-inch (8") and smaller shall be mechanical joint gate valves; valves which are 12-inch (12") and larger shall be mechanical joint butterfly valves. As approved by the Engineer, 16 and 24-inch (16 and 24") Mechanical Joint Resilient Seat Wedge Gate Valves with non-rising stems, as manufactured by American Flow Control, may be used in place of 16 and 24-inch (16 and 24") butterfly valves. The valve operator may be either a top or side operator as approved by the Engineer. The use of ball valves or globe valves for use with the connection of 2 or 2-1/2 inch (2 or 2 1/2") water lines will not be allowed. All tapping sleeves and tapping valves shall be installed by the City of Wichita Water and Sewer Department. The Contractor shall provide excavation, thrust blocking, and backfill for the installation.

Concrete supports shall be provided under valves in vaults. The support shall be constructed one inch (1") low and the void between the valve and the support shall be filled with non-shrink grout. Buried valves shall be supported on poured concrete blocks.

Valve boxes are to be installed on all valves including blowoff assembly valves. The valve boxes shall be installed in accordance with the standard detail drawings. Valve boxes shall be held vertical and plumb during backfill operations.

Valve operator extensions shall be installed on all valves where the operator stem is in excess of seven feet (7') or more below proposed grade. The operator extension shall bring the operating nut to within five feet (5') of the proposed surface.

All valves shall be installed in accordance with these specifications. The valve installation shall include excavation, concrete support blocking, valve box, and any other material to provide the item complete and in place at the unit price bid.

803.8 VAULTS

Valve vaults shall be required only as indicated by the project plans. The vault shall be constructed of reinforced concrete conforming to Subsection 406.2 of these specifications.

The Contractor shall be required to provide all materials and labor to provide the item complete and in place at the unit price bid.

803.9 FIRE HYDRANTS

The Contractor shall furnish all labor, materials, and equipment necessary to install fire hydrants complete and in place at locations shown on the plans in accordance with the standard details and special provisions. Fire hydrants furnished by the contractor shall conform to the requirements of Subsection 803.3.

Paint that has been damaged, chipped, or scraped, shall be repaired as directed by the Engineer.

All fire hydrants shall be faced away from the street and/or bagged, until such time as the hydrant is placed in service. The hydrant shall be turned to face the street, at the proper grade, plumb, fully flushed, and in good working order before it will be accepted. The fire hydrant control valve at the main shall be left open.

The Contractor shall provide the fire hydrant bid item complete and in place at the unit price bid.

803.10 CONNECTIONS TO EXISTING MAINS

The Contractor shall be required to fully excavate the existing main for any adjustment of the line and grade of the new main. Such adjustment shall be as directed by the Engineer and approved prior to construction and shall be considered subsidiary to the installation of the water main project.

All connections to existing mains shall be in accordance with the project plans.

Valves connecting new mains to the existing mains shall remain closed at all times. If it is necessary to obtain water from the existing water system, the Engineer shall be contacted for approval. After approval has been granted, valves may be operated only if the Engineer or his representative is present. After the valve has been operated, it shall be closed and left in the closed position until the line is to be flushed and cleared. After disinfection and testing is completed, the new water line may be released for service upon completion of project documentation.

When an existing water line must be shut down to make a connection, the Contractor, Engineer, and Wichita Water and Sewer Department Representative, shall discuss the timing of the shut down and make any necessary arrangements to make the shutdown. The shutdown time shall be held to a minimum to avoid disruption of service to the water customers. The Contractor shall make the necessary notification to those affected by the proposed shutdown. Such notice shall be in writing and given a minimum of 48 hours ahead of the proposed shutdown. The Contractor shall notify the Engineer who will then notify the Wichita Water and Sewer Department when the main is returned to service.

803.11 TAPPING SLEEVES, VALVES AND VALVE BOXES ON WATER LINES

Description:

Tapping sleeves are to be installed by the Wichita Water and Sewer Department at all locations where indicated by the project plans. The Contractor shall contact the Engineer to arrange for the installation of the tapping sleeve.

Installation:

The Contractor shall perform all excavation and backfill for the installation. The Contractor shall expose the existing pipe prior to the installation of the tapping sleeve so that the Water and Sewer Department may determine the type of tapping sleeve required for the installation. After the installation of the tapping sleeve and valve, the Contractor shall extend the new water line from the connection, construct the thrust block behind the tapping sleeve and valve, and install the valve box during the backfilling operation. The valve box is to be vertical and plumb.

When tapping the main is required by the project plans for the connection of the new main to the existing main, the Contractor shall contact the Engineer, who will make the necessary arrangements for having the main tapped by the Water and Sewer Department. The Contractor shall not tap the existing main unless authorized in writing by the Water and Sewer Department and the Engineer.

The connection to the existing main shall be considered subsidiary to the pipe installation unless otherwise indicated by the bid proposal. If part of the bid proposal, the item shall be provided complete and in place.

803.12 METER SERVICE CONNECTIONS

On projects where the Contractor will be installing water services and meter setters, the water services shall be installed as directed by the Engineer. The following items shall be included in the water service and meter setter bid items shown in the bid proposal. The Contractor shall provide all material and labor to provide the item complete and in place at the unit price bid for the item.

Water Services:

For projects requiring the installation of water services or replacement of water services, the Contractor shall be required to install a new water service line from the new main and connect the service line to the existing water meter setter. New water service lines shall be one inch (1") where replacement of existing 5/8", 3/4", or 1" water service lines is required. Where existing water service lines are larger than one inch (1"), the new service line shall be the same size as found and connected to existing meter setter, using adapters as required. When replacement of the existing meter setter is required, a minimum of three feet (3') of one inch (1") copper tubing shall be installed on the consumers side of the setter. The contractor shall provide the inspector with a list of materials used in the meter box assembly. The one inch (1") water service bid items shall include the following: installation of a one inch (1") service saddle, installation of new one inch (1") service line, connection of the new service line to the existing meter setter, adapters as necessary for the connection, new 21" PVC meter boxes, new meter rings, new meter lids, and all other material and labor to furnish the bid item complete and in place. The Contractor may reuse 21" meter boxes that are made of PVC or metal that has not been damaged, as approved by the Engineer. The Contractor may contact the Wichita Water and Sewer Department to determine which services are to be replaced prior to construction, as approved or directed by the Engineer. The Contractor shall be paid for only those services installed or replaced, regardless of the number of services bid, at the unit price bid for the appropriate bid item.

Water Meter Setters:

Water meter setters shall be replaced as approved and directed by the Engineer. The existing water meter setter shall be used if it is in satisfactory condition and of suitable material. If the existing meter setter is not usable, a new one inch (1") meter setter shall be installed. The existing water meter shall be reused and reinstalled using the appropriate adapters. An existing water meter setter that may not be reused, shall be abandoned by removing the old meter setter, crimping the existing service line shut, removing the existing meter ring, lid, and box, and filling the hole with sand. Such abandoning shall be considered subsidiary to the meter setter bid item and not bid or paid for separately. The Contractor shall be paid for the actual number of water meter setters installed, regardless of the number of meter setters bid, at the unit price bid for the meter setter bid item. The old meter rings and lids shall be returned to the Wichita Water and Sewer Department material yard at 1701 Sim Park Drive at no additional cost to the bid item.

803.13 FIRE SERVICE LINE CONNECTIONS

Fire service line connections shall be made in accordance with the plans and the standard details.

The fire service line from the control valve at the main to the detector check valve shall be constructed of ductile iron pipe regardless of length.

Fire service lines shall be constructed in accordance with plans that have been approved by the Department of Public works and the Wichita Fire Department.

803.14 BLOCKING

All pipe lines, fire hydrants, valves, and fittings are to be blocked with concrete thrust blocks in accordance with standard details. Horizontal thrust block bearing area calculations are to be based on a test pressure of 150 psi, and undisturbed soil bearing of 1,000 psf in clay soils, and 2,000 psf in sand-gravel soils. Vertical thrust blocks shall be sized to resist thrust with an equal weight of concrete if the block is above the fitting. The concrete for thrust blocking shall conform to Subsection 406.2. Cost for the installation of concrete thrust blocks shall be considered subsidiary to the pipe installation and not bid or paid for separately.

803.15 TESTING**General:**

Water lines, including all fittings and connections to the water mains shall be tested for watertightness by subjecting each section of water line to hydrostatic tests in accordance with applicable provisions of AWWA C-600, except as modified below. The tests shall include both pressure and leakage testing. The Contractor shall provide all equipment, material, and labor to perform the required testing.

Pressure Tests:

Water lines, including all fittings and connections to the water mains shall be tested for watertightness by subjecting each section to pressure test. The pressure shall be measured at the lowest end of the section under test. The pipe is to be tested at a test pressure of 150 psi. The duration of the test is to be two hours unless otherwise directed by the Engineer. Each section of the project is to be tested separately as per AWWA C-600, or as modified by these specifications. A section of less than 500 feet may be tested with the next adjacent section, however, testing of sections longer than ½ mile in total pipe length shall not be allowed unless written approval from the Engineer has been provided.

Pressure testing may begin only after appropriate backfilling has been completed and the last concrete thrust block has set for seven days, unless high early strength concrete was used, in which case the block must set for 36 hours prior to testing. The pipe to be tested shall be filled slowly with water and allowed to stand for 24 hours to allow for absorption. After the 24-hour period, the test may begin. Any exposed valves, fittings, pipe sections, and fire hydrants, etc., shall be examined during the pressure test for cracks, leaks, or other signs of leakage. The pipe section is to be pumped to 150 psi and the pressure gages observed for the duration of the test. The pressure shall not vary more than 5 psi during the testing period. The pipe sections that do not pass testing, shall be repaired or replaced with sound material as directed by the Engineer, at the expense of the Contractor. The test shall be redone after repairs have been made. Only after the section has passed the test shall the section be accepted.

Leakage Test:

Leakage is defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

The duration of the leakage test shall be 2 hours unless otherwise directed by the Engineer. The leakage test is to be performed after the pressure test. The pressure during the leakage test is to be the working pressure of the system. The test shall be conducted in the same manner as the pressure test except that the Engineer shall provide suitable equipment for measuring the amount of leakage.

Permissible leakage is determined by the following formula:

$$L = \frac{ND}{P} \div 4500$$

In which

L = Allowable leakage in gallons per hour

N = Number of joints in the pipe line being tested, this "N" being the standard length of pipe furnished divided into the length being tested, with no allowance for joints at branches, blowoffs, fittings, etc.

D = Nominal pipe diameter in inches

P = Average observed test pressure of the pipe being tested, equal to at least 100 percent of the class rating of the pipe being tested, in psi gage, based on the elevation of the lowest point in the line or section under test and corrected to the elevation of the test gage

A table showing allowable leakage is shown below.

Table 803-1

Allowable leakage per 1000 feet of pipeline in gallons/hour (GPH)

Avg. Test Pressure	Normal Pipe Diameter							
PSI	4	6	8	12	16	20	24	36
150	0.37	0.55	0.74	1.10	1.47	1.84	2.21	3.31
125	0.34	0.50	0.67	1.01	1.34	1.68	2.01	3.02
100	0.30	0.45	0.60	0.90	1.20	1.50	1.80	2.70
75	0.26	0.39	0.52	0.78	1.04	1.30	1.56	2.34
50	0.21	0.32	0.42	0.64	0.85	1.06	1.27	1.91

Should any section have leakage greater than shown in the table or calculated by the above

formula, the section shall be repaired or material replaced with sound material and the test redone. Only after the section has passed the test shall the section be accepted.

Testing and the associated repair and retesting of the water line shall be considered subsidiary to the pipe installation and not paid for separately.

803.16 DISINFECTION

After pressure and leakage testing has been performed and the sections found acceptable, the entire water line, including valves, fittings, fire hydrants, etc., shall be disinfected. All valves in the line and including fire hydrants and valves, shall be operated during the disinfection procedure.

All valves in the line and including fire hydrants and valves, shall be operated during the disinfection procedure. Cost of disinfection shall be considered subsidiary to the pipe installation and not bid or paid for separately.

Disinfection of water mains for the City of Wichita shall conform to the current requirements of the Kansas Department of Health and Environment (KDHE). The disinfection procedures shall be followed to ensure the water in the new water system being installed is free from bacteria. The KDHE disinfection procedures are located in Appendix A-1. Cost for the disinfection of the water line shall be considered subsidiary to the pipe installation and not paid for separately.

SECTION 804

SEWER LINE CONSTRUCTION

804.1 DESCRIPTION

The construction of sewer lines shall conform to the applicable standard specifications and details, except as otherwise modified in the special provisions.

804.2 MATERIALS

Concrete:

Concrete and materials for concrete shall conform to the City of Wichita Standard Specifications for concrete pavement, Subsection 406.2, except as modified herein. Cement used in concrete for sanitary sewer manholes shall be Type II. Cement used in all other concrete shall be Type I/II. All cement shall comply with the requirements of the latest revisions of ASTM C-150.

The Engineer shall have the authority to instruct the Contractor to substitute high early strength (Type III) cement for Type I/II cement. In this event, the Contractor will be allowed as an extra the difference in cost between standard Portland cement and high early strength (Type III) cement.

Reinforcing Steel:

Reinforcing steel shall conform to the same requirements as specified in the City of Wichita Standard Specifications for Concrete Pavement, Subsection 406.2.

Mortar (Grout):

Mortar used in constructing brick masonry structures shall contain eight (8) sacks of Type II Portland cement per cubic yard, fine aggregate, and sufficient water to produce mortar of desired consistency. Fine aggregate for mortar shall conform to the requirements specified for concrete pavement, except that it shall have a gradation factor not less than 2.75 and shall be free from dust, loam or dirt.

Brick:

Brick shall meet the requirements for grade MS in ASTM C-32 or grade SW in ASTM C-62. Brick dimensions shall be suitable for wall thicknesses shown on the plans.

Manhole Castings:

Manhole castings shall be made of good quality gray iron, free from cracks, holes, swells and cold shuts. Manhole castings shall be manufactured to conform to the shape and dimensions and other requirements as shown on standard manhole detail. Manhole castings shall conform to Class 30 of ASTM A-48.

Stormwater/Sanitary Pipes:

- a) **Clay Pipe** - All clay pipe shall be extra strength vitrified clay pipe conforming to the requirements of the latest revision of ASTM C-700. Individual pieces shall not be less than five feet (5') in length, except that shorter pieces may be used to facilitate connections at manholes.

Clay pipe shall be installed with an improved bedding conforming with the standard drawing.

All pipe shall be subject to inspection at the factory, on the job site, or at any other location prior to construction. Purpose of the inspection shall be to cull and reject pipe which, independent of the strength tests herein specified, fail to comply with the requirements of the specifications. All rejected pipe shall be plainly marked by the inspector and shall be replaced by the Contractor without additional cost. Pipe will be rejected when the allowable variations as specified in the latest revision of ASTM C-700 are exceeded or when pipe fails to give a clear ringing sound when placed on one end and tapped with a light hammer. The City of Wichita reserves the right to make strength tests at any time. Should the pipe tested fail to meet strength herein specified, additional tests will be made up to one percent (1%) of the total shipment. If one percent (1%) of the pipe delivered in one shipment fails to meet the tests, all the pipe will be rejected. If the pipe tested satisfactorily passes the strength requirements, Contractor will be expected to furnish, free of cost, not more than one pipe per thousand placed in the ditch. If the City elects to break more than one pipe in a thousand after the first pipe has passed its satisfactory strength test, the City will pay the Contractor at the unit price bid for the additional pipe broken.

Clay pipe may be either bell and spigot pipe or plain end pipe. Bell-and-spigot pipe shall have compression joints which conform to the requirements of the latest revision of ASTM C-425, Type I, except that the sealing element on both the bell and the spigot shall be affixed to the pipe in the factory. Plain end pipe shall have compression couplings which conform to the latest revision of ASTM C-594 for Type B coupling, except that the rigid external sleeve coupling for jointing the pipe shall be affixed to one end of the pipe in the factory. A lubricant shall be used as recommended by the manufacturer to facilitate the joining of the pipe.

- b) Polyvinyl Chloride Composite Pipe** - Polyvinyl (P.V.C.) Composite Sewer Pipe shall conform with the latest revision of ASTM D-2680. Joints shall be rubber gasketed. All pipe ends shall be sealed with a suitable sealant as recommended by the pipe manufacturer to prevent air intrusion into the pipe wall filler material during the low pressure air testing. PVC Composite Pipe shall be installed in accordance with the manufacturer's recommendations. PVC Composite Pipe shall be installed with an improved bedding in accordance with the standard drawing for composite pipe. Waterstop gaskets shall be furnished and installed on the pipe in all manhole walls. PVC Composite Pipe shall have a Certification of Compliance executed by an accredited independent testing laboratory.
- c) Polyvinyl Chloride Pipe** - Polyvinyl Chloride (P.V.C.) Pipe having diameters of eight inches (8") or greater shall have elastomeric gasketed joints and shall conform to the latest revision of ASTM D-3034 for 15-inch and smaller pipe, and to ASTM F-679 for 18-inch and larger pipe, and shall be rated for SDR-35. All PVC pipe shall be installed in accordance with manufacturer's recommendations. Waterstop gaskets around the pipe shall be installed in all manhole walls. PVC pipe shall be installed with an improved bedding in accordance with the standard detail.

Pipe furnished may be P.V.C. pipe meeting the requirements of the latest revision of ASTM F789, unless otherwise noted on the plans. Such pipe shall have a Certification of Compliance executed by an accredited independent testing laboratory. Pipe joints shall be elastomeric gaskets meeting the requirements of the latest revision of ASTM D-3212. Such pipe shall be installed in conformance with the applicable requirements specified for PVC pipe in the preceding paragraph. Approved waterstop gaskets shall be furnished and installed on the pipe in all manhole walls.

- d) **Reinforced Concrete Pipe (Sanitary)** - Reinforced concrete pipe for sanitary sewers shall be circumferentially reinforced concrete pipe with O-ring rubber gasketed steel joints. The pipe shall be reinforced with a cage or cages formed with circumferential and longitudinal steel. Steel joint rings shall be constructed at the ends of each length of pipe and securely fastened to the reinforcing steel in the pipe. Each pipe shall be constructed with self-centering steel joints sealed with a rubber gasket and capable of withstanding normal movement, due to displacement in the backfilled sewer trench. Pipe joints shall be sealed by a rubber gasket so that the joint will remain tight for normal conditions of service, due to movement from expansion, contraction and backfill operations. The gaskets shall be fabricated from high-grade rubber compound and shall conform to the requirements of the latest revision of ASTM Designation C-443.

Each pipe shall be provided with bell-and-spigot ends formed by steel joint rings securely fastened in the pipe and to the pipe reinforcement. The spigot ring shall be lined with concrete on its interior surface and the bell ring shall be covered with concrete on its exterior surface. Any portion of the steel joint ring which is exposed after the pipe is manufactured shall be protected from corrosion by means of metallic zinc not less than 0.002 inch thick applied by the metalizing process. The spigot end of the steel joint shall be designed to receive, hold and protect the gasket. The joints shall be self-centering so that the gasket will not support the weight of the pipe. Rubber and steel joints shall be installed in strict conformance with the pipe manufacturer's recommendations. Steel joint rings and gaskets shall be cleaned prior to joining and an approved lubricant shall be used to facilitate the joining. The inside bottom one-third of joint recesses between adjacent pipe shall be filled and pointed with mortar such that no mortar will extend inside the pipe beyond the inside circumference of the pipe. Joint recesses on the outside of the pipe shall be completely filled for the full circumference of the pipe using mortar and diaphragms. The pipe supplier shall submit shop drawings to the Engineer for approval prior to manufacturing any pipe.

All reinforced concrete pipe for sanitary sewer shall be plastic lined over the upper 300 degrees segment of the pipe. The plastic lining may be Amer-Plate T-Lock Liner Plate, B.F. Goodrich Lok-Rib Koroseal, or an approved equal. The plastic liner shall be white or near white in color. Manufacturer's recommendations for installing, sealing joints, testing and inspection of the plastic lining shall be considered as incorporated in and forming a part of these specifications. The pipe supplier shall furnish to the Engineer three (3) copies of plastic lining manufacturer's recommendations prior to the fabrication of any pipe. Plastic liner shall be white or near white in color.

All reinforced concrete pipe for sanitary sewers shall be Class III pipe, unless specified otherwise by the plans. Circular reinforced concrete sanitary sewer pipe shall conform to the requirements of the latest revision of ASTM C-76 for Wall B, except as otherwise specified. Reinforced concrete arch sanitary sewer pipe shall conform to the latest revision of ASTM C-506, except as otherwise specified. Reinforced concrete elliptical sanitary sewer pipe shall conform with the latest revision of ASTM C-507, except as otherwise specified.

Control tests shall be made during the manufacture of reinforced concrete sanitary sewer pipe to determine strength and absorption. Control tests shall be made by an independent testing laboratory at the expense of the Contractor.

- e) **Ductile Iron Pipe (Sanitary)** - Ductile iron pipe shall conform to ANSI A21.51 or AWWA C151 and shall be Thickness Class 52, unless otherwise noted on the plans. Joints shall be either push-on joints or mechanical joints manufactured in accordance with Federal Specification WW-P-421 C. When specified by the plans, ductile iron pipe shall be furnished with flexible joints capable of deflecting a minimum of twelve and one-half degrees (12-1/2). Flexible joints shall be "Molox" as manufactured by American Cast Iron Pipe Company, "Usiflex" as manufactured by the United States Pipe & Foundry Company, or an approved equal. All exterior surfaces of ductile iron pipe shall be coated with a bituminous coating approximately one mil thick. The inside of ductile iron pipe to be used in constructing sanitary sewers having diameters of eight inches (8") or larger shall be lined with a chemically inert liner such as "Polylined" as manufactured by United States Pipe & Foundry Company, "Polybond" as manufactured by American Cast Iron Pipe Company, or an approved equal. The chemically inert liner shall have a nominal thickness of 40 mils and a minimum thickness of 20 mils. Ductile iron pipe for use in sanitary sewer construction may be coal tar epoxy coated as manufactured by Griffin Pipe Products Company. Coal tar epoxy coating material shall be either 46H41 3 Hi-Build Tneme Tar or Bitumastic No. 300-M applied as recommended by coating manufacturer using two coats which results in a minimum dry film thickness of 16 mils. Other coatings may be used when approved by the Engineer. Ductile iron pipe shall be used only when specified by plans or proposal.

Ductile iron pipe shall be installed with an improved bedding in accordance with the standard drawing.

- f) **Ductile Iron Pipe (Storm)** - Ductile iron pipe shall conform to ANSI A21.51 or AWCA C151 and shall be Thickness Class 52, unless otherwise noted on the plans. Joints shall be either push-on joints or mechanical joints manufactured in accordance with Federal Specification WW-P-421C. When specified by the plans, ductile iron pipe shall be furnished with flexible joints capable of deflecting a minimum of twelve and one-half degrees (12-1/2). Flexible joints shall be "Molox" as manufactured by American Cast Iron Pipe Company, "Usiflex" as manufactured by the United States Pipe & Foundry Company, or an approved equal. All exterior surfaces of ductile iron pipe shall be coated with a bituminous coating approximately one mil thick. The inside of ductile iron pipe to be used in constructing storm sewers having diameters of eight inches (8") or larger shall have a one-sixteenth inch (1/16") thick cement lining with a bituminous coating in accordance with ANSI A21 .4 or AWWA C104. Ductile iron pipe shall be used only when specified by plans or proposal. Ductile iron pipe shall be installed with an improved bedding in accordance with the standard drawing.
- g) **Reinforced Concrete Pipe (Storm)** - Reinforced concrete pipe for storm sewers shall be Class III pipe, unless specified otherwise by the plans. Circular reinforced concrete storm sewer pipe shall conform to the requirements of the latest revisions of ASTM C-76 for Wall B. Reinforced concrete arch storm sewer pipe shall conform to the latest revision of ASTM C-506. Reinforced concrete elliptical storm sewer pipe shall conform with the latest revision of ASTM Designation C-507. Joints shall be tongue and groove joints sealed with either flexible plastic gaskets or cement mortar. Flexible plastic gaskets shall conform to the requirements of the latest revision of AASHTO M-198 for Type B gaskets. The gasket manufacturer shall certify to the Engineer that he has examined the appropriate detailed joint drawings of the pipe manufacturer and has recommended the specific size and number of wraps of gasket to be employed in the joints of pipe sizes proposed for the project.
- h) **Corrugated Metal Pipe** - Corrugated steel pipe shall be galvanized steel and shall conform to the applicable provisions of KDOT Standard Specifications, Section 1905.

All corrugated steel pipe furnished up to and including a circular diameter of sixty-six inches (66") or metal pipe arches smaller than 66" x 51" shall have corrugations with a pitch of two and two-thirds inches (2-2/3") and a depth of one-half inch (1/2"). All corrugated steel pipe specified larger than circular diameter of sixty-six inches (66") or metal pipe arch sizes larger than 64" x 43" shall have corrugations with a pitch of three inches (3") and a depth of one inch (1"). Corrugated steel pipe used in the construction of storm sewers and culverts shall be furnished with the "Hugger" band couplers manufactured by Conctect Steel Corporation, or an approved equal, for connecting sections of corrugated steel pipe. The coupling bands shall be furnished and installed with gaskets such that the connection will be tight when completed to preclude entrance of backfill material into the pipe.

Corrugated steel pipe shall be of the size and type as shown on plans, corrugated steel pipe gage requirements shall conform with the minimums as shown in the following table unless otherwise shown on plans:

<u>Circular Pipe Size in Inches</u>	<u>Arch Pipe Size in Inches</u>	<u>Minimum Gage</u>	<u>Minimum Sheet Thickness in Inches</u>
15 (See Note)	17x13 (See Note)	12	0.109
18	21x15	12	0.109
21	24x18	12	0.109
24	28x20	12	0.109
30	35x24	12	0.109
36	42x29	12	0.109
42	49x33	12	0.109
48	57x38	12	0.109
54	64x43	12	0.109
60	66x51	12	0.109
66	73x55	12	0.109
72	81x59	12	0.109
78	87x63	10	0.138
84	95x67	10	0.138
90	103x71	10	0.138
96	112x75	8	0.168

Note: Twelve gage fifteen-inch (15") or 17"x13" CMP may not always be available. RCP may be substituted for these sizes. RCP with a diameter of 12" may be substituted for 17"x13" CMP. Such substitutions can be made with the Engineer's approval.

Circular corrugated steel pipes larger than ninety-six inches (96") and corrugated steel pipe arches larger than 112" x 75" require special consideration, and the requirements for the larger pipes will be specified on the plans.

Any damage to pipe or coating shall be repaired by the Contractor as approved by the Engineer. Scrapes or scratches penetrating the galvanized coating shall be painted with zinc-rich paint. Damaged pipe, which in the opinion of the Engineer cannot be satisfactorily repaired, shall be replaced by the Contractor.

Ungalvanized welds and pipe ends shall be factory painted with zinc-rich paint, and any areas where the galvanizing has been damaged is shipping or installation shall be field painted with zinc rich paint. Zinc-rich paint shall be a one-component material manufactured as a coating for steel and have a minimum of 85% zinc weight in the dried film.

i) **Closed Profile PVC Pipe -**

1. **Scope:** This specification covers Closed Profile polyvinyl chloride (PVC) pipe and fittings made to a controlled inside diameter in sizes 21" to 48" with an integral bell and elastomeric seal joints which meet the requirements of ASTM D-1784.
2. **Physical Dimensions:** Pipe dimensions shall conform to the requirements in the following table when measured in accordance with ASTM D-2122:

Pipe Dimensions			
<u>Normal Size</u>	<u>Average O.D.</u>	<u>Wall Thickness</u>	<u>Average I.D.</u>
21"	22.110"	0.680"	20.76"
24"	25.116"	0.770"	23.50"
27"	28.232"	0.886"	26.50"
30"	31.416"	0.965"	29.50"
36"	37.800"	1.150"	35.50"
42"	44.200"	1.350"	41.60"
48"	50.570"	1.535"	47.50"

3. **Pipe Stiffness:** The minimum pipe stiffness shall be 46 psi when tested in accordance with ASTM D-2412.
4. **Flattening:** Pipe shall show no visual evidence of cracking, splitting or breaking when flattened between parallel plates in a suitable press to 60 percent deflection in accordance with ASTM D-2412.
5. **Fusion Quality:** Pipe shall show no sign of flaking or disintegration when immersed in an anhydrous acetone for 20 minutes as described in ASTM D-2152.
6. **Impact Resistance:** The impact resistance of closed profile PVC sewer pipe shall meet the requirement of 21-24 inch (21-24") 220 foot/pounds when tested in accordance with ASTM D-2444.
7. **Marking:** Each joint of pipe shall be marked with the following information: Size, Company name, PVC Sewer Pipe, ASTM F-794-'88, Manufacturers Code, Cell Classification and Pipe Stiffness.
8. **Workmanship:** The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions and other injurious defects.

j) **Ribbed Wall PVC Pipe -**

1. **Scope:** This specification covers Ribbed Wall pipe with a smooth interior and a solid cross-sectional rib exterior for use in gravity flow applications as sanitary sewer. Exterior ribs shall be perpendicular to the axis of the pipe. Such pipe may be Extrusion Technologies "Ultra-Rib" or an approved equal. Ribbed PVC sewer pipe shall meet the requirements of ASTM F-794 and Uni-Bell B-9.
2. **Physical Dimensions:** Pipe dimensions shall conform to the requirements of the following table when measured in accordance with ASTM D-2122.

Pipe Dimensions

<u>Normal Size</u>	<u>Average O.D.</u>	<u>Major Wall Min. Thickness</u>	<u>Average I.D.</u>
8"	8.8"	0.105"	7.89"
10"	11.0"	0.105"	9.86"
12"	13.1"	0.105"	11.74"
15"	16.07"	0.118"	14.37"
18"	19.76"	0.150"	17.65"

3. **Pipe Stiffness:** The minimum pipe stiffness at 500 deflection shall be 60 psi for all sizes when tested in accordance with ASTM D-2412.
4. **Flattening:** Pipe shall show no visual evidence of cracking, splitting or breaking when flattened to 60 percent deflection in accordance with ASTM D-2412.
5. **Extrusion Quality:** Pipe shall not disintegrate or flake when tested in accordance with ASTM D-2152.
6. **Impact Resistance:** The impact resistance of ribbed PVC sewer pipe shall meet the requirements shown below when tested in accordance with ASTM D-2444:

8-inch 210 ft/lbs
10-18-inch 220 ft/lbs

7. **Marking:** Each joint of pipe shall be marked with the following information: Size, Company name, PVC Sewer Pipe, ASTM F-794-'88, Manufacturers Code, Cell Classification and Pipe Stiffness.
8. **Workmanship:** The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions and other injurious defects.

k) **Cured in Place Pipe (CIPP) -**

The tube material shall meet the requirements of ASTM F 1216, Section 5.1.

1. The tubes shall have a uniform thickness that when compressed at installation pressures will equal the specified nominal tube thickness.
2. The tube shall be fabricated to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance shall be made for circumferential stretching during inversion.
3. The outside layer of the tube (before inversion) shall be plastic coated with a translucent flexible material that clearly allows inspection of the resin impregnation (wetout) procedure. The plastic coating shall not be subject to delamination after curing of the CIPP.
4. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No materials shall be included in the tube that are subject to delamination in the cured CIPP.
5. The wall color of the interior pipe surface of the CIPP after installation shall be a light reflective color so that a clear detail examination with closed circuit television inspection equipment may be made.

6. The resin system shall meet the requirements of ASTM F 1216.
7. The CIPP shall be designed as per ASTM F1216, Appendix XI. The CIPP design shall assume no bonding to the original pipe wall.
8. The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers; nor shall separation of the layer occur during testing performed under the requirements of this specification.

804.3 PIPE INSTALLATION

General:

Trench excavation, pipe bedding, backfilling and compaction shall comply with Section 801.

Sewer pipe shall be installed to line and grade as shown on the plans. Pipe shall bear uniformly along its length with notches excavated where necessary to accommodate pipe.

The sewer pipe shall be laid up grade beginning with the lowest elevation, unless otherwise approved by the Engineer. The sewer pipe shall be installed with the bell end or upstream, unless otherwise approved by the Engineer. When pipe laying is not in progress, the forward end of the pipe shall be kept tightly closed with an approved temporary plug.

Any sewer lines having flow elevations which deviate by more than one inch (1") from a straight line, as determined by the flow line of the two ends of pipe of any one line between the structures, shall be reconstructed by the Contractor at his expense such that the flow elevations will not deviate by more than one inch (1") from a straight line.

Only one kind of pipe may be used on each project unless shown otherwise on the plans or approved by the Engineer.

Joint Gaps:

Maximum allowable gaps measured at the widest point and maximum allowable offsets in the flowline between butting ends of pipe shall be as indicated in the following table. Joint gap requirements shown in the following table shall be applicable only to those types of pipes with joints where the bell socket is designed with an inner face which would normally seat with the butt end of the pipe installed into the bell socket for such pipe as clay pipe, concrete pipe and other such pipe types.

Pipe Size	Joint Gap	Flowline Offset
8"	1/2"	3/16"
10"	1/2"	3/16"
12"	1/2"	1/4"
18"	11/16"	1/4"
21"	7/8"	3/8"
24"	7/8"	3/8"
27"	15/16"	1/2"
30"	15/16"	1/2"
36" or larger	1"	1/2"

Reinforced Concrete Pipe Joints (Storm):

Joints shall be tongue and groove joints sealed with either flexible plastic gaskets or cement mortar.

Tongue and groove joints shall consist of a concrete tongue (spigot) and a concrete groove (bell). The spigot and bell shall be integral parts with the pipe barrel. Joints utilizing collars instead of bells as an integral part with the pipe barrel will not be permitted.

Pipe joints shall be round and true subject to permissible variations specified in Section 11 of ASTM C-76.

The seating surfaces of the concrete bell and spigot shall be parallel to one another and the annular space between the seating surfaces shall not exceed the following dimensions:

<u>Pipe Diameter</u>	<u>Annular Space</u>
12"-18"	7/32"
21"-27"	1/4"
30"	5/16"
33"-48"	3/8"
54"-66"	7"1/6"

For pipe sizes larger than 66", the pipe manufacturer shall submit to the Engineer for approval, prior to pipe manufacture, detailed joint drawing which specifically indicate annular space.

The seating surfaces shall be free from air holes, chipped or spalled concrete, or other defects which would be harmful to the integrity of the joint.

Gaskets shall be installed in accordance with the manufacturer's recommendations. The Contractor shall submit to the Engineer a copy of these recommended procedures prior to pipe installation for his review and approval. Such procedure shall specifically indicate the number and location of wraps of joint sealant required for pipe sizes proposed for the project.

When mortar joints are used, the annular space in pipe joints shall be filled with cement mortar consisting of one part Portland cement to two parts sand and 6-1/2 to 7 gallons of water per each sack of cement.

Cement mortar sealant shall be installed in accordance with the following procedures:

The joint surfaces shall be thoroughly cleaned immediately before the joint is made. A layer of cement mortar is placed on the lower one-half of the bell end of the installed pipe and on the upper one-half of the spigot end of the pipe section to be installed. The spigot is then inserted into the bell of the installed pipe until the sealant material is squeezed out on the interior and exterior surfaces. Any annular joint space between the adjacent pipe ends shall be filled with mortar and the excess mortar on the inside of the pipe wiped clean and finished smooth. The annular joint space shall be completed, filled with mortar and the abutting joint sections shall be flush and even.

804.4 MANHOLES/INLETS

Manhole Top Elevation:

The intent of this specification is to insure that tops of manholes will be constructed to match proposed finished grade in areas of new development and existing finished grade in areas which have already developed. The intent is to construct sewer manholes outside of paved or unpaved street, driveway, parking lot or traveled ways to an elevation of 0.4' higher than the proposed finished grade or the existing finished grade. Tops of manholes constructed in proposed or existing paved traveled ways shall be set flush with the proposed or existing pavement. Tops of manholes constructed in proposed or existing unpaved traveled ways shall be constructed to an elevation of six inches (6") below the proposed or existing finished grade.

Plan elevations may need to be adjusted in the field at the time of construction in conformance with the requirements in this specification as approved by the Engineer.

When the plans do not indicate top of manhole elevations, the manhole top elevation shall be ascertained at the time of construction using the best information available in conformance with the requirements of this specification as approved by the Engineer.

Structure Excavation and Backfill:

Excavation for structures, backfill for structures and compaction of such backfill shall conform to the applicable requirements as specified for sewer pipe trenches (Section 801).

Shallow and Special Shallow Manholes Type A and Type B:

Shallow Manholes Type A and Type B shall be brick manholes constructed to conform with the requirements as shown by standard manhole detail. Manholes shall be built according to the dimensions and having the thickness of wall as shown on the plans. Portland cement mortar shall be used in laying the brick. All brick shall be laid with shove joints. The outside of manholes shall be plastered with cement mortar; the same as is used in the joints, entirely covering the outside surface.

The floors of the manholes shall be shaped and smoothed so that flow channels will be formed such that the manholes will be self-cleaning and free of areas where solids may be deposited as sewage flows through the manhole from all inlet pipes to the outlet pipe. The floors shall have slopes of three inches (3") per foot on areas outside of the flow channels.

Brick manholes shall not be backfilled until the mortar has cured for twenty-four (24) hours.

Manholes Type A and Type B:

Manholes Type A and Type B shall be brick manholes constructed to conform with the requirements as shown by standard manhole detail. Manholes shall be built according to the dimensions and having the thickness of wall as shown on the plans. Portland cement mortar shall be used in laying the brick. All brick shall be laid with shove joints. The outside of the manholes shall be plastered with cement mortar, the same as is used in the joints, entirely covering the outside surface.

Brick manholes shall not be backfilled until the mortar has cured for twenty-four (24) hours.

Manholes Type C and Type D:

Manholes Type C shall be cast in place circular concrete manholes constructed to conform with requirements as shown by standard manhole detail.

Manholes Type D shall be cast-in-place, circular concrete manholes coated on the inside with an approved epoxy coating in conformance with requirements as shown by standard manhole detail. Epoxy coating will not be required on the inside of Type D manholes when such manholes are constructed on sewers smaller than 10" diameter. The interior surfaces, excluding brick masonry surfaces, of Type D manholes shall be coated with two coats of Tnemec Series 66 Hi-Build Epoxy or other approved equal, with each coat having a minimum dry film thickness of 4 mils when constructed on sewers having a diameter of 10" or more. Interior concrete surfaces to be coated with an epoxy coating shall be broomed or brushed with grout to fill voids in the surface prior to applying the epoxy coating.

Forms used in the construction of cast-in-place, circular concrete manholes shall be inspected and approved by the Engineer prior to use. The forms shall be fabricated in sections which will permit easy installation and removal without damage to completed manhole. The forms shall be constructed such that the walls will have a thickness of eight inches (8") without any form marks on the interior or exterior protruding more than one-fourth inch (1/4").

The concrete base may be placed integral with the walls or the base can be placed separately as approved by the Engineer. An approved waterstop gasket shall be installed in the joint between the manhole walls and base when the base is placed separately from the walls. The floor of the manhole shall be shaped and smoothed so that flow channels will be formed such that the manhole will be self-cleaning and free of areas where solids may be deposited as sewage flows through the manhole from all inlet pipes to the outlet pipe. The floor shall have a slope of three inches (3") per foot outside of the flow channels.

The maximum permissible slump for concrete used in the construction of cast in place manholes is four inches (4"). The concrete shall be placed in the forms in two-foot (2') layers in such a manner that will prevent segregation. The concrete in the manhole base and each layer of concrete in the manhole walls shall be thoroughly rodded or vibrated to eliminate honeycombing. Forms shall not be removed from the walls of the manhole until the concrete has set up sufficiently to prevent damage to the walls by the form removal operation. The length of time between the placing of concrete and removal of forms will vary, depending upon weather conditions.

Backfilling will not be permitted until a period of twelve (12) hours has expired after the removal of the forms. The Contractor shall be required to provide an adequate method for curing the concrete during the period between the removal of forms and prior to completion of the backfilling operation.

Manhole locations which require pipe inlets through cast-in-place, circular manhole walls will be constructed by cutting an opening in the manhole wall at the proper location after the forms have been removed. The pipe will then be installed in the opening using the correct alignment and grouted in place. The space between the pipe and the manhole wall shall be completely filled with grout. All grouting shall be done with non-metallic shrinkage correcting grouts such as Master Builder's "Embeco713; Set Products, Inc. "Set"; or an approved equal. The grouted inlet pipe connection shall be sealed on the exterior with Bituminastic Super Service Black as manufactured by Koppers, Tarmastic 103 as manufactured by United States Steel, 450 Heavy Tenemecol as manufactured by Tnemec or an approved equal. Application shall conform to manufacturer's requirements.

Reinforced Concrete Manholes:

Reinforced concrete manholes constructed on sanitary sewers shall have all areas of concrete that would otherwise be exposed to sewer gases, except the floors, protected with plastic lining. The plastic lining for reinforced concrete manholes shall conform to the same requirements as specified for plastic lining for reinforced concrete sanitary sewer pipe. Reinforced concrete manholes shall not be backfilled until a period of seventy-two (72) hours has expired after the removal of the forms.

The floors of the manholes shall be shaped and smoothed so that flow channels will be formed such that the manhole will be self-cleaning and free of areas where solids may be deposited as sewage flows through the manhole from all inlet pipes to the outlet pipe. The floors shall have slopes of three inches (3") per foot on areas outside of the flow channels.

Precast Concrete Manholes Type P:

Precast Concrete Manholes Type P shall be constructed as detailed by standard detail sheet in conformance with the latest revision of ASTM C 478, except for the following modifications:

- a) Thickness of precast sections shall be at least one-twelfth (1/12) of the internal shell diameter plus one inch (1"), or five inches (5") total, whichever is greater. The minimum internal diameter of manholes shall be 4 feet.
- b) Joints between precast reinforced concrete sections shall provide for the use of mastics or rubber gaskets (natural or synthetic) to prevent leakage or infiltration.
- c) Precast sections shall be adequately reinforced with steel to withstand erection and temperature stresses.
- d) The bottom sections of all precast reinforced manholes shall extend into the cast-in-place-manhole base a minimum distance of four inches (4"). When cast-in-place bases are used, the bottom section of the reinforced precast manhole shall extend into the base a minimum of four inches (4").
- e) Precast reinforced concrete manholes shall conform to the dimensions and requirements of the standard details.
- f) All interior surfaces of precast concrete manholes to be connected to sewer pipe shall receive a troweled or broomed grout finish to fill air holes and irregularities prior to applying the epoxy coatings. The interior surfaces shall be painted with two coats of Tnemec Series 66 Hi-build epoxy or other approved equal. When the paint coating is applied by the manufacturer, surfaces which are to be grouted or patched shall not be painted until after assembly of the manhole. The Contractor shall apply epoxy to touch up damaged surfaces and cover patches or grouted areas. Each application of epoxy coating shall have a minimum dry film thickness of 4 mils.
- g) The floors of the manholes shall be shaped and smoothed so that flow channels will be formed such that the manhole will be self-cleaning and free of areas where solids may be deposited as sewage flows through the manhole from all inlet pipes to the outlet pipe. The floors shall have slopes of three inches (3") per foot on areas outside of the flow channels.
- h) All grout used to close openings around waterstop gaskets and sewer pipes shall contain approved non-metallic shrinkage correcting aggregate.

Inlets:

Inlets are to be brick or reinforced concrete as indicated by the plans. Inlet cover castings and inlet ring castings shall conform to the same requirements as specified for manhole castings except for weight.

Brick inlets shall not be backfilled until the mortar has cured for twenty-four (24) hours. Reinforced concrete inlets shall not be backfilled until a period of seventy-two (72) hours has expired after the removal of the forms.

Inlets with concrete tops shall have rings and covers according to the following schedule.

<u>Inlet Length (Feet)</u>	<u>Number of Rings & Covers</u>
5	1
10	2
15	3
20	4

The rings shall be spaced such that there is a maximum of two and five-tenths feet (2.5') from the inside of the end wall to the center of the ring and a maximum of five feet (5') from center to center between rings. Rings and covers shall be centered between the front and the back of the concrete tops. The number and spacing of rings with covers may vary from this specification only when approved by the Engineer. At least one manhole ring and cover shall be placed such that it is aligned with the centerline of the outfall pipe or pipes.

The floors of the inlets shall be shaped and smoothed so that flow channels will be formed such that the inlets will be self-cleaning and free of areas where solids may be deposited as storm water flows through the inlets from all inlet areas to the outlet pipe. The floors shall have slopes of three inches (3") per foot on areas outside of the flow channels.

Precast Inlets:

When shown on the plans or approved by the Engineer, precast inlets may be used. Precast inlets shall be manufactured in accordance with the detail sheet for the type of inlet to be supplied.

804.5 TESTING

Pipeline Testing and Inspection:

All storm sewers twelve inches (12") or larger and all sanitary sewers larger than six inches (6") shall be inspected visually or with a television camera by the City of Wichita prior to acceptance by the City. All eight-inch (8") through twenty-four inch (24") sanitary sewers constructed under this contract shall be air tested by the City of Wichita prior to acceptance. The Contractor will be required to conduct exfiltration tests on sanitary sewers larger than twenty-four inch (24") prior to acceptance by the City. Any infiltration or exfiltration requirements for storm sewers will be set forth on the plans or in supplemental specifications.

Any defects indicated by the visual or television inspection, air testing and/or exfiltration testing shall be corrected by the Contractor without additional compensation prior to final acceptance of the project by the City. The lines shall be retested and reinspected after repairs have been made by the Contractor.

Air testing shall consist of measuring the amount of time required for the pressure to drop one (1) psi from a starting pressure of approximately four (4) psi in the length of sewer being tested between manholes. Permissible elapsed time for a pressure drop of one (1) psi shall be four (4) minutes for eight-inch (8") pipe; five minutes for ten-inch (10") pipe; five and one-half minutes for twelve-inch (12") pipe; seven and one-half minutes for fifteen-inch pipe; eight and one-half minutes for eighteen-inch (18") pipe; ten minutes for twenty-one inch (21") pipe; and eleven and one-half minutes for twenty-four inch (24") pipe.

Exfiltration testing shall be conducted on sewers larger than twenty-four inch (24") under the supervision of the Engineer. The Contractor shall conduct exfiltration testing on each reach of sanitary sewer pipe larger than twenty-four inch (24") between manholes. Exfiltration tests shall be conducted by blocking off manhole openings except those connecting within the reach being tested, filling the line with water and measuring the water required to maintain a constant level in the manholes. Each manhole shall be subjected to at least one exfiltration test. During the exfiltration test, the maximum water depth at the lower end shall not exceed twenty-five feet (25') and the minimum depth of water at the upper end shall be at least five feet (5') above the top of the pipe or the groundwater elevation on the outside of the pipe, whichever is greater. The total exfiltration shall not exceed two hundred (200) gallons per inch of nominal diameter per mile of pipe per day for each reach tested. Manholes shall be considered as sections of pipe for purposes of determining the maximum allowable leakage. The exfiltration test shall be maintained on each reach of pipe for a minimum of two hours and as much longer as necessary to locate all leaks. The Contractor shall provide at his own expense all necessary equipment, labor and materials required for the test. The methods used and the time of conducting the exfiltration tests shall be subject to the approval of the Engineer. All leaks or other defects shall be repaired to the satisfaction of the Engineer. Any reach which exceeds the allowable maximum shall be retested after the leaks are repaired.

PVC pipe and any other flexible pipe may be subject to testing for deflection after it has been installed and backfilled. Deflection may be tested by a mandrel or by direct measurement of the vertical diameter of the pipe. Pipe that has deflected more than five percent (5%) of its nominal dimension shall be reconstructed, repaired or reconstructed by the Contractor at his expense. The reconstructed pipe shall also be tested for deflection. Testing of pipe with a diameter of thirty-six inches (36") or less shall be by a mandrel, and the Contractor shall be required to furnish all equipment and labor necessary to complete the testing. Testing of pipe with a diameter greater than thirty-six inches (36") shall be by direct measurement by the Engineer's representative.

The cost of all additional testing and inspection in connection with repair work necessary to correct deficiencies in completed work on this project will be charged to the Contractor and may be deducted from the amount due on the final estimate.

Testing of Manholes:

All manholes shall be tested for leaks upon completion of backfill operations. Tests, sealing, and acceptance shall be according to this specification.

Prior to testing, all lifting holes and exterior joints shall be filled and pointed with an approved non-shrinking mortar. The completed manhole shall be backfilled before testing of manholes.

Manholes shall be tested using the full depth exfiltration or vacuum test method.

- a) Full Depth Exfiltration Method** - Full depth exfiltration with a water loss of less than 1.14 gallons per foot of depth per day for a 24-hour test period.

Testing shall be performed in the presence of a representative of the City of Wichita.

- b) Vacuum Test Method** - Vacuum test per the following description:

1. All pipes and other openings into the manhole shall be plugged. All plugs shall be securely braced to prevent the plug from being drawn into the manhole.
2. Air shall then be pumped out of the manhole until a vacuum is created inside of the manhole equal to ten inches (10") of mercury on an approved vacuum gauge. The

removal of air will then be stopped and the test time will begin.

3. The vacuum must not drop to below 9 inches (9") of mercury within a 60 second test period for a four-foot (4') diameter manhole, 75 seconds for five-foot(5') diameter manhole and 90 seconds for a six-foot (6') diameter manhole. If more than a one-inch (1") drop in vacuum occurs within the test period the manhole shall be considered unacceptable. Contractor shall excavate the manhole and make necessary repairs. Upon completion of repairs the manhole shall be backfilled again and retested.

804.6 INCIDENTAL CONSTRUCTION

Manholes/Inlets Removed:

Manholes/Inlets designated for removal shall be completely removed. All abandoned pipes which remain after the manhole/inlet has been removed shall be plugged. The excavation shall be backfilled in accordance with the requirements as specified for sewer trench backfill.

All castings and covers shall be salvaged, cleaned and delivered to the City Maintenance Yard.

Observation Holes Removed:

Observation holes designated for removal shall be completely removed for the full depth to the top of the tee fitting in the sanitary sewer, unless otherwise indicated by the plans. The opening left by removing the observation hole shall be plugged with concrete as approved by the Engineer. The top half of the sewer pipe shall be encased with a minimum thickness of six inches (6") of unreinforced concrete encasement for a minimum of eighteen inches (18") in both directions from the centerline of the original observation hole.

Manholes Adjusted:

Manholes designated for adjustment shall be raised or lowered as necessary such that the casting will conform to the required elevation. Construction and material requirements shall conform to the same requirements as specified for new manhole construction. An approved type of flat concrete slab shall be used to support the manhole ring where it is necessary to lower manholes or brick stacks having corbels more than twelve inches (12"). Flat concrete slab manhole tops shall conform to the requirements of A.S.T.M. C-478 in addition to the following requirements.

A minimum six inch (6") brick collar conforming to the same type of construction as specified for brick manholes shall be installed between the manhole ring and the flat concrete slab to facilitate minor adjustments for elevation unless approved otherwise by the Engineer. All contact surfaces between brick masonry, flat concrete slab and cast iron ring shall be sealed with a layer of mortar. Manholes having corbels which must be raised more than twelve inches (12") will require removing the draw section completely to facilitate reconstruction of a standard draw section. When it is necessary to adjust a reinforced concrete manhole, this work shall conform to the requirements and details as shown by the plans.

Inlets Adjusted:

Inlets designated for adjustment shall be raised or lowered as necessary such that the top of the inlet will conform to the required elevation. Construction and material requirements shall conform to the same requirements as specified for new inlet construction.

Manholes Abandoned:

Manholes designated to be abandoned shall have the top four feet (4') removed and the remaining portion of the manhole shall be filled with sand, flushed and vibrated. All pipes in the manhole which are to be abandoned shall be plugged prior to filling with material similar to the adjacent surface and compacted to a density of ninety percent (90%) of the standard density. Manhole castings shall be

salvaged, cleaned and delivered to the City Maintenance Yard.

Connection to Existing Manholes or Inlets:

When it is necessary to connect a new sewer to an existing inlet or manhole which does not have a stub to facilitate this connection, the Contractor shall core drill into the manhole or inlet unless otherwise approved by the Engineer. All repair work necessary to close the opening made to facilitate the installation of the new pipe shall conform to the requirements for new construction as specified in these specifications for the type of manhole or inlet involved. The floor of the manhole or inlet shall be modified such that smooth channels will be formed from all inlet pipes to the outlet pipe such that the manhole or inlet will be self-cleaning and free of areas where solids could be deposited as water flows through the structure in accordance with such requirements specified for new manhole or inlet construction.

No payment will be made for connecting new sewer pipes to existing manholes or inlets and all costs for completing this work shall be considered as subsidiary to the other items of work except when a bid item appears in the proposal for this work.

Pipe Abandoned in Place:

Both ends of all pipes to be abandoned in place shall be plugged. Pipes abandoned in place having diameters greater than fifteen inches (15") shall be filled with sand or grout and plugged.

Riser Pipe:

Riser pipe shall be installed to serve individual lots or tracts in conjunction with new sanitary sewer construction, unless otherwise ordered by the Engineer, because of groundwater, unstable soil or unusually deep construction. Riser locations shall be as approved by the property owner with the concurrence of the Engineer. Installation of risers on sewers because of unusual depth will be required when the sewer is deeper than twelve (12'). The Contractor will be required to file written documentation with the Engineer on a form approved by the Engineer indicating the locations where risers are to be installed as requested by the property owner or his authorized representative. Riser pipe construction shall conform to the requirements as shown on the standard riser detail sheet. Contract quantities pertaining to riser installation may or may not be utilized on the project, based on the decision of the Engineer with regard to trench conditions. It should be understood by the Contractor that the necessity for installation of risers and the final pay quantity for such work will largely depend on the job conditions and may vary greatly from contract quantity or may not be utilized at all and the Contractor should prepare his bid accordingly.

Pipe Stub-Outs:

Four-inch (4") and six-inch (6") pipe stubs with temporary pipe plugs shall be installed in manholes when shown on the plans or directed by the Engineer to facilitate connection of building service lines. All four-inch (4") and six-inch (6") clay pipe stubs shall be extra-strength clay pipe conforming with the latest revision of ASTM C-700. Four-inch (4") and six-inch (6") PVC stubs shall be Schedule 40.

Pipe Plugs:

Pipe plugs shall be constructed of brick masonry. Pipes having diameters of eighteen inches (18") or smaller shall be plugged with masonry plus eight inches (8") thick. Pipes having diameters of greater than eighteen inches (18") shall be plugged with masonry plugs twelve inches (12") thick. Construction requirements and materials for brick masonry plugs shall conform to the same requirements as specified for brick manholes.

Temporary pipe plugs on the ends of lines which are to be extended in the future shall be prefabricated by the manufacturer of the pipe unless approved otherwise by the Engineer. Temporary plugs shall be of such construction that when they are installed, the plug will prevent entrance of any extraneous material into the sewer and such that will facilitate easy removal without

undue damage to the sewer pipe when the sewer is extended.

Temporary pipe plugs on sewers to be extended in the future will not be paid for directly and this cost shall be included in the price bid for the pipe.

Reinforced Concrete Encasement:

Reinforced concrete encasement shall be constructed to conform with the standard detail drawing. Concrete and reinforcing steel used in the construction of reinforced concrete encasement shall conform to the requirements as specified in the Standard Specifications for concrete pavement construction (Subsection 406.2).

Reinforced Concrete Cradle:

Reinforced concrete cradle shall be constructed to conform with the standard detail drawing. Concrete and reinforcing steel used in the construction of reinforced concrete cradle shall conform to the requirements as specified in the Standard Specifications for concrete pavement construction (Subsection 406.2).

Septic Tank System Removal:

If in the prosecution of the construction of any sanitary sewer it becomes necessary to remove a portion of, or a complete septic tank, the inspector shall notify the Engineer and the Contractor that if a portion of the tank is removed the entire tank shall be removed and a temporary connection established. A change order must be executed for this extra work before the Contractor can proceed with the removal of the septic tank.

It will be necessary for the Contractor to obtain a permit for the temporary connection for which the normal fee will be waived and request an inspection of the connection from the Engineering Sewer Inspector. All work involved with building sewer line construction or connections shall be in accordance with the code of the City of Wichita.

The Contractor shall notify the tenant or property owner that the septic system is removed and a temporary connection established and also inform the tenant or property owner that the Office of Central Inspection (OCI) shall be notified and requested to make an approved inspection of all plumbing in the building or residence. With this approval, the connection will become permanent. All of the aforementioned shall be in accordance with the Code of the City of Wichita.

In the event the lead line or the laterals from the septic system are encountered in the construction of the sewer, the Contractor shall make all necessary repairs for which no additional payment shall be made.

The inspector shall record on the daily record cards the location of the temporary connection as measured from a reference manhole and the side of the sewer where the temporary connection is made.

SECTION 805

THERMOSETTING RESIN POLYESTER FELT LINER PIPE (CURED-IN-PLACE PIPE)

805.1 INSPECTION OF SEWERS TO BE LINED OR RECONSTRUCTED

- a) Prior to commencing lining or reconstruction of a sewer line, the Contractor shall televise and videotape the full length of sewers to be lined or reconstructed.
- b) The Contractor shall insure that flow is being discharged from all live service connections to the sewer to be lined or reconstructed during the television inspection to verify locations of live service connections. The Contractor shall contact all adjacent property owners and coordinate with the City to insure that flow will be discharged during television inspection.
- c) Videotapes and logs shall be given to the City of Wichita, Sewer Maintenance Division, at the completion of the work and shall contain both the preliminary and post construction versions. Tapes shall be adequately labeled to insure easy reference of location. All tapes shall be of high quality and clarity and shall show the complete footage of each line, to the satisfaction of the Engineer and in a format acceptable to the Sewer Maintenance Division.
- d) Alternate methods to the above live service connection location will be considered. Any deviation to the above procedure shall be approved by the Engineer. Television inspection prior to lining or reconstructing a sewer will not be paid for directly and this cost shall be considered as subsidiary to the other contract pay items of work.
- e) All television inspections of the existing sewer and the lined sewer competed by the Contractor shall be recorded on tape cartridges which are compatible to equipment presently used by the Sewer Maintenance Division to view such tapes.

805.2 GENERAL SPECIFICATIONS

- a) **Intent** - It is the intent of this portion of this specification to provide for rehabilitating pipelines by the insertion of a flexible polyester felt liner. The liner shall be saturated with a thermosetting resin and inverted into the existing pipeline utilizing an inversion tube and hydrostatic head. Curing shall be accomplished by circulating hot water to cure the resin into a hard impermeable pipe. When cured, the hardened liner should extend from end to end of the section being lined in a continuous tight fitting watertight pipe-within-a-pipe.
- b) **Reference Specifications and Manufacturer's Standards** - This specification references ASTM F-1216 and manufacturer's standards which are made a part hereof by such reference and shall be the latest edition and revision thereof.
- c) **General Corrosion Requirements** - The finished liner shall incorporate thermosetting materials which will withstand the corrosive effects of the normal existing effluents, liquids or gases and shall meet the chemical resistance requirements of ASTM F-1216, Appendix X2.
- d) **Flow Analysis (Industrial Areas Only)** - In industrial areas which may be subject to chemical waste discharges which can damage thermosetting plastics, the City will obtain samples of the flow and have them analyzed. This analysis will be supplied to the Contractor for his information and use.

- e) **Liner Length** - The length of the liner shall be that deemed necessary by the Contractor to effectively carry out the inspection and seal the liner at the inlet and outlet points. It will not be permissible to terminate the liner within the pipe. The Contractor shall verify the lengths in the field before cutting the liner to length. Individual inversion runs can be made over one or more access points as determined in the field by the Contractor and approved by the Engineer.
- f) **Liner Material and Cured Lining** - The polyester felt tubing, including the polyurethane or polyethylene coated felt and the thermosetting resin shall meet the liner manufacturer's standards. The lining material shall be a polyester fiber felt tubing, lined on one side with polyurethane or polyethylene and fully impregnated with a liquid thermosetting resin as specified. The cured lining material shall conform to the minimum structural standards as listed below:

<u>CURED LINER</u>	<u>STANDARD</u>	<u>RESULTS</u>
Flexural Stress	ASTM D-790	4,000 psi
Modulus of Elasticity	ASTM D-790	400,000 psi

The Contractor shall furnish for approval by the Engineer, prior to the "Notice to Proceed", the following:

1. Satisfactory written guarantee of his compliance with the liner manufacturer's standards for all materials and techniques being used in the inversion lining process.
 2. A design, using the equations contained in ASTM F-1216, using the documented physical properties of the resin proposed, and using a safety factor of two, indicating the required liner pipe wall thickness for each section to be lined. Documentation by third party testing as to the long term Modulus of Elasticity, as a percentage of the initial, shall be attached to the design. The approved designed wall thickness shall be installed unless the Engineer has specifically noted a liner pipe wall thickness in the bid documents. In either event, the wall thickness specified will be the minimum furnished thickness that is acceptable.
 3. A report of Field Sample Test Results listing the physical properties of liner pipes of the same type which have been installed by the Contractor for previous projects.
- g) **Deviations** - The deterioration of pipelines is an ongoing process. Should pre-lining inspections reveal the pipes to be in substantially different conditions than those stated in the design considerations, then the Contractor shall request a change in liner thickness supporting such request with design data in accordance with the liner manufacturer's standard design policies. The added or reduced cost for the deviation, if approved, shall be negotiated separately with the City.

805.3 CONSTRUCTION REQUIREMENTS

Installation Procedures:

The following installation procedures shall be adhered to unless otherwise approved by the Engineer:

- a) **Safety** - The Contractor shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements. Particular attention is drawn to those safety requirements involving working with scaffolding and entering confined spaces.
- b) **Cleaning of Pipelines** - Prior to any lining of a pipe so designated, it shall be the

responsibility of the Contractor to remove internal deposits from the pipeline using accepted sewer cleaning techniques.

- c) **Inspection of Pipelines** - Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit television. The interior of the pipeline shall be carefully inspected to determine the location and extent of any structural failures. The location of any conditions which may prevent proper installation of lining materials into the pipelines shall be noted so that these conditions can be corrected.

Prior to lining, the preliminary video tape of the host pipe shall be reviewed and approved by the Engineer to assure that the host pipe requires no further protruding tap cutting, point repairs or cleaning in preparation for lining. During this review the Contractor and Engineer will agree on which of the service connections are active and are therefore to be reopened after the lining is complete. Only the active service connections will be reopened.

- d) **Bypassing Flow** - The Contractor, when required, shall provide for the transfer of flow around the section or sections of pipe that are to be lined. The bypass shall be made by diversion of the flow at an existing upstream access point and pumping the flow into a downstream access point or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The proposed bypassing system shall be as approved in advance by the Engineer. The approval of the bypassing system in advance by the Engineer shall in no way relieve the Contractor of his responsibility and/or public liability.

The Contractor shall make arrangements as necessary with adequate notification to involved property owners and/or tenants, to insure that waste water will not be discharged from building sewer lines during the installation of the liner pipe or until such time building sewers are reconnected to the liner pipe and functional.

No service connection operation will be interrupted by construction for more than 12 hours unless the Contractor has made arrangements for the building occupants, such as temporary housing. Services connections of businesses that require water to function will be separately bypassed to avoid an adverse impact on their operation.

- e) **Line Obstructions** - It shall be the responsibility of the Contractor to clear the line of obstructions such as solids that will prevent the insertion of the liner. Obstructions which cannot be removed by conventional cleaning methods shall be repaired as indicated by the plans prior to insertion of the liner. These repairs will not be an additional pay item, but will be considered as incidental to the other contract pay items of work.

Installation of Liner:

- a) The Contractor shall designate a location where the uncured resin in the original containers and the UN-impregnated liner will be vacuum impregnated prior to installation. The Contractor shall allow the Engineer to inspect the materials and "wet out" procedure. A resin and catalyst system compatible with the requirement of this method shall be used. The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used. A roller system shall be used to uniformly distribute the resin throughout the tube.
- b) **Liner Insertion** - The "wet out" liner material shall be inserted through an existing manhole or other approved access by means of an inversion process and the application of a hydrostatic head sufficient to fully extend the liner to the next designated access point. The impregnated liner materials shall be inserted into the inversion tubes with the impermeable plastic

membrane side out. At the lower end of the inversion tube, the liner tube shall be turned inside out and attached to the inversion tube, the liner tube shall be turned inside out and attached to the inversion tube so that a leak-proof seal is created. The inversion head will be adjusted to be of sufficient height to invert the liner to the next access point designated and to hold the liner snug to pipe wall and to produce dimples at side connections and flared ends at the entrance and exit access points. The use of a lubricant is recommended and if used, such lubricant shall be as approved by the liner manufacturer's standards. The liner manufacturer's standards shall be closely followed during the elevated curing temperature so as not to over stress the felt fiber and cause damage or failure of the liner prior to cure. (In certain cases, the Contractor may elect to use a Top Inversion. In this method, the liner is pre-inverted to a distance that corresponds to the minimum inversion head and instead of attaching to an elbow at the base of the inversion tube, the liner is attached to a top ring.)

- c) **Liner Curing** - After inversion is completed, the Contractor shall supply a suitable heat source and water re-circulation equipment. The equipment shall be capable of delivering hot water to the far end of the liner through a hose, which has been perforated per the liner manufacturer's recommendations, to uniformly raise the water temperature in the entire liner above the temperature required to effect a cure of the resin. This temperature shall be determined by the resin/catalyst system employed.

The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat exchanger circulating water. Thermocouples shall be placed between the liner and the invert at near and far access to determine the temperature of the liner and time of exotherm. Water temperature in the line during the cure period shall not be less than 150°F or more than 200°F as measured at the heat exchanger return line.

Initial cure shall be deemed to be completed when inspection of the exposed portions of the liner appear to be hard and sound and the thermocouples indicate that an exotherm has occurred. The cure period shall be of the duration recommended by the resin manufacturer, as modified for the inversion lining process, during which time the re-circulation of the water and cycling of the heat exchanger to maintain the temperature in the liner continues.

- d) **Cool-down** - The Contractor shall cool the hardened liner to a temperature below 100°F before relieving the static head in the inversion tube. Cool-down may be accomplished by the introduction of cool water into the inversion tube to replace water being drained from a small hole made in the end of the liner at the downstream end. Care shall be taken in the release of the static head such that a vacuum will not be developed that could damage the newly installed liner.
- e) **Finish** - The finished lining shall be continuous over the entire length of an insertion run and be as free as commercially practicable from visual defect such as foreign inclusions, dry spots, pinholes and de-lamination. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to the inside of the lined pipe.

Any defects which will affect the integrity or strength of the lining shall be repaired at the Contractor's expense, in a manner mutually agreed by the Engineer and the Contractor.

Sealing Liner at the Ends:

If, due to broken or misaligned pipe at the access point, the lining fails to make a tight seal, the Contractor shall apply a seal at that point. The seal shall be of a resin mixture compatible with the liner.

Branch of Service Connections:

After the liner has been cured, the Contractor shall reconnect the existing active service

connections. This shall be done without excavation and, in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a cutting device that re-establishes them to not less than ninety percent (90%) capacity.

Only active service connections will be reopened. Any inactive service connection which has been inadvertently opened will be sealed closed by the Contractor to the satisfaction of the Engineer.

Liner Testing:

The water-tightness of the liner shall be gauged while the liner is curing and under a positive head. After the work is completed, the Contractor will provide the Engineer with a video tape showing both the before-lined and after-lined conditions, including the restored connections.

Physical Properties Testing:

A sample section from each inversion run shall be saved. The Engineer may randomly select samples to be tested for the Modulus of Elasticity (initial), in accordance with ASTM D-790, by an approved independent testing laboratory. The long term Modulus of Elasticity of the pipe will be calculated from the data on the approved design submittal. The sample section shall be made by inverting through cylindrical form placed in the manhole invert. The test report shall be approved by the Engineer prior to the final contract payment. The costs of the tests shall be subsidiary to the other contract pay items of work.

Clean-up: Upon completion of the installation work and after required testing indicates the lining is acceptable, the Contractor shall clean up the project area affected by the work. Any damage by the Contractor to public or private property shall be restored to original or better condition as determined by the Engineer.

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SECTION 806

FORM HIGH MODULUS PVC LINER PIPE

806.1 SCOPE

This specification provides for the rehabilitation of gravity flow pipe lines by the insertion of a preheated, folded PVC pipe which is then further heated and progressively unfolded and expanded against the interior surface of the existing pipe. The finished Fold and Form Pipe (FFP) should extend over the installation length in a continuous, tight fitting pipe-within-a-pipe.

806.2 REFERENCE SPECIFICATION

This specification references American Society of Testing and Materials (ASTM) standards F-1504, D-3034 and D-1784 which are made a part hereof by such reference and shall be the latest edition and revision thereof. In case of a discrepancy between the ASTM Standards and this Specification, the most conservative of the two will apply.

806.3 MATERIALS

- a) The PVC compound used for the FFP shall conform to ASTM D-1784 classification 13223-B, 12334-B or 12344-B.
- b) The minimum length of the FFP shall be that deemed necessary by the Contractor to effectively span the distance between the starting point and the terminating point, unless otherwise specified.

806.4 DESIGN

The Dimensional Ratio (DR), the Pipe Diameter divided by the Wall Thickness, shall be determined by the Formulae contained in Appendix XI of ASTM F-1216. The long-term (time dependent) Flexural Modulus used in these calculations shall be no greater than 35% of initial, for the cell classifications identified in Section 3.1. The following table has been prepared in accordance with this requirement.

MAXIMUM SAFE DEPTH FOR FFP

CELL CLASS	E-MOD (PSI)	DIMENSIONAL RATIOS		
		35	41	50
13223-B & 12334-B	320,000	20'	14'	9'
12344-B	360,000	22'	16'	10'

Assumptions:

Existing pipe is not capable of loading, soil 120 lb/cf, Soil Modulus 700 psi, Ground Water ½ total depth, Ovality 2%, Live Load is 16,000 lb./wheel, long-term Modulus of PVC is 35% of initial Modulus per ASTM D-790. Safety Factor is 2.

806.5 SAFETY

The Contractor shall carry out the operation in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving entering and working in confined spaces.

806.6 INSTALLATION PREPARATION

- a) All debris which would interfere with the installation of the FFP shall be removed.
- b) Inspection of pipelines shall be performed by experienced personnel trained in locating and identifying breaks, obstructions and service connections by closed circuit television. The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the FFP into the existing sewer line. Such conditions shall be noted so that these conditions can be corrected prior to installation.
- c) The line shall be cleaned of obstructions such as solids, displaced joints, protruding service connections or collapsed pipe that may prevent FFP installation. If the TV inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, a point repair shall be made to remove or repair the obstruction. These preparatory items are incidental to the lining process, and are not additional pay items.
- d) Prior to lining, the preliminary video tape of the host pipe shall be reviewed and approved by the Engineer to assure that the host pipe requires no further protruding tap cutting, point repairs or cleaning in preparation for lining. During this review the Contractor and Engineer will agree on which of the service connections are active and are therefore to be reopened after the lining is complete. Only the active service connections will be reopened.
- e) When required, flow of sewage around the section or sections of pipe designated for FFP shall be provided by the Contractor. The bypass shall be made by plugging the line at an existing upstream manhole and pumping or directing the sewage flow into a downstream manhole or adjacent system, if the adjacent system has capacity for the additional flow. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Raw sewage must be pumped back into the sanitary sewer system or disposed of in a manner approved by the City, but such approval shall in no way relieve the Contractor of his responsibility and/or public liability.
- f) No service connection operation will be interrupted by construction for more than 12 hours unless the Contractor has made arrangements for the building occupants, such as temporary housing. Service connection of businesses that require water to function will be separately bypassed to avoid an adverse impact on the operation.

806.7 INSTALLATION

- a) The minimum length of the FFP shall be that deemed necessary by the Contractor to effectively span the distance from the starting point to the terminating point, unless otherwise specified.
- b) The spool of FFP shall be heated to make the PVC pipe flexible for insertion into the existing pipe.

- c) The FFP shall be inserted into the existing pipe using a winch and cable connected to the end of the FFP. The winch shall be equipped with a dynamometer to record the pulling forces required during installation. The maximum force exerted on the FFP shall be a tensile stress of 350 psi (when heated) multiplied times the pipe wall cross sectional area.
- d) Thermocouples shall be placed against the pipe at both the upstream and downstream end to monitor the pipe installation temperatures.
- e) Once the necessary processing temperature has been achieved the FFP shall be expanded using a pressure-driven rounding device that progressively expands and forms the pipe mechanically from the insertion point to the termination point. Expansion pressure shall be sufficient to unfold the FFP, press it tightly against the wall of the existing pipe and form dimples at the service connections.
- f) After the FFP is completely rounded and prior to relieving the pressure holding the FFP against the existing pipe the Contractor shall cool the FFP, using air and/or water, to a temperature below 110 degrees.

806.8 SERVICE CONNECTIONS

After the pressure is removed from the FFP, the Contractor shall re-establish the existing, **live** service connections. This shall be done without excavation from the interior of the pipeline by means of a CCTV camera and a remote controlled cutting device that fully re-establishes the **live** service connection. Only active service connections will be reopened. Any inactive service connection which has been inadvertently opened will be sealed closed by the Contractor to the satisfaction of the Engineer.

806.9 WORKMANSHIP

The finished FFP shall be continuous over the entire length of the installation and conform to the contours of the walls of the host pipe. After work is completed the Contractor shall provide to the City a copy of the original video tape and a video of the completed sewer line showing all work completed including all services that were re-connected. All tapes shall be of high quality and clarity and shall show the complete footage of each line, to the satisfaction of the Engineer.

806.10 CLEANUP

After installation of the FFP has been completed and required testing indicates that the FFP is acceptable the project area disturbed by the Contractor's operation shall be restored to its original or better condition in compliance with AR 78 as determined by the Engineer.

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SECTION 807

MANHOLE REHABILITATION

807.1 DESCRIPTION

This Specification controls the rehabilitation of sewer manholes, and repair of voids and infiltration and the installation of a monolithic, fiber reinforced, sulfide resistant coating with a minimum thickness of 3/8" to provide structural integrity and be impervious to flows of water. Deviations from the procedures will only be allowed with the Project Engineer's approval. The Contractor may, at his option, reconstruct the manhole in lieu of rehabilitating the manhole.

807.2 MATERIALS

Manhole Sealing Material:

- a) **Quick Setting Cementitious Patch Mix:** the cementitious mix shall conform to the following requirements:

Compressive Strength	6 hours -350 psi minimum 24 hours-2260 psi minimum
Shrinkage	0% @ 90% Relative Humidity as per ASTM C-591
Bond	145 psi as per ASTM C-321
Cement	The cement utilized shall be a calcium aluminate cement resistant to high sulfide environments

- b) **Cementitious Mixture for Coating:** The Cementitious mix shall conform to the following minimum requirements at 28 days:

Compressive Strength	ASTM C-109	>4000 psi
Tensile	ASTM C-496	>580 psi
Flexural	ASTM C-293	>780 psi
Shrinkage	ASTM C-596	0% when cured at 95% relative humidity.
Sulfate Resistance	ASTM C-267	No attack, 28 days in 2000 ppm aqueous sulfuric acid solution
Water/Cement Ratio		.36--.45
Bond	ASTM C-882	>130 psi
Cement		Calcium Aluminat
Density		Applied material not to exceed 120 lbs./cu. ft.

Chemical Grout:

- a) Grout shall be nonmetallic shrinkage correcting grout.
- b) Acceptable Products:
1. Master Builder's "Embeco 713"
 2. Set Products, Inc. "Set"
 3. Approved Equal

Mortar Grout:

Shall comply with requirements of Subsection 804.2.

Castings:

Shall comply with requirements of Subsection 804.2.

807.3 CONSTRUCTION REQUIREMENTS**Cleaning of Manholes:**

- a) Manholes to be rehabilitated shall be cleaned with a high-pressure water blast to remove dirt, slime, grease, deposits and debris. Detergents may be used to help remove materials adhering to the walls and bench.
- b) Deteriorated mortar shall be removed by the water blast or by hammer and chisel until firm mortar is exposed.
- c) Manholes to be sealed shall be washed down to the extent that the dirt and debris does not interfere with the sealing process.

Manhole Steps:

- a) Any existing steps shall be removed. The holes shall be filled with Chemical Grout.

Manhole Sealing:

- a) Furnish and install new castings, adjust casting to grade if required with brick and mortar per Standard Specifications. Corbel to be rebuilt as required to match new castings. Missing corbel brick shall be replaced and joints pointed as required.
- b) After water blast cleaning, structural defects shall be repaired by replacing loose or missing brick, tuck-pointing joints and pipe entrances, sealing actively infiltrating areas with chemical grouts, adjusting castings to grade and removing any existing steps.
- c) Invert repair shall be performed on all inverts with visible damage or infiltration. After thoroughly cleaning the invert to be repaired and blocking flow through the manhole, the quick-setting mix shall be applied to the invert in an expeditious manner (placement time 10 min. maximum). The mix shall be troweled uniformly onto the damaged invert extending out onto the base of the manhole sufficiently to tie into the monolithic coating to be applied. The finished invert surfaces shall be smooth and free of ridges. The flow should be re-established in the manhole a minimum of 15 minutes after placement of the mix.
- d) Prior to spraying the coating, the manhole surface shall be damp without noticeable free water droplets or running water. Spray coating material to a uniform thickness sufficient to insure that all voids and crevices are filled and a smooth surface remains after troweling. The troweling shall compact materials into voids and crevices and set the bond on the manhole surface (brick, tile block or concrete).

After the first application has taken an initial set, but while tacky to touch, spray a second coat to assure a minimum total thickness of 3/8" and trowel to a smooth finish. A one(1) coat application is acceptable provided the applicator/contractor can assure a minimum of 3/8" thickness after troweling. After the application to the walls, the wooden covers are removed and the bench is sprayed from the walls to the invert in such a manner so as to produce a bench having a gradual slope from the wall to the invert with the wall/bench intersection built up and rounded to a uniform radius at the circumference of the intersection.

The thickness of the bench shall be no less than 1/2" at the invert and shall increase in the direction of the wall so as to provide the required slope.

No application shall be made when ambient temperatures are less than 40 degrees within the manhole and when freezing is expected within 4 hours. If ambient temperatures are in excess of 90 degrees F., precautions shall be taken to keep mixing water below 85 degrees F., using ice if necessary.

It is recommended that the final application have a minimum of four (4) hours cure time before being subjected to active.

Bench and Invert Repair:

Benches and channels shall be built up, formed with maximum radii, and sealed with brick, mortar sealant, and concrete as required to provide a sealed and properly constructed bottom per Standard Specifications.

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SECTION 808

MICROTUNNELING INSTALLATION OF PIPE

808.1 DESCRIPTION

The Contractor shall furnish and install pipe by microtunneling as indicated and in conformity with this specification. The work includes, but shall not be limited to traffic control, excavation, dewatering, removal of all materials encountered in microtunneling operations, disposal of all material not required in the work, grouting, bulkheads, backfilling and site restoration.

The Contractor shall provide a microtunneling process which uses a remotely operated shield machine for installing pipes or pipe linings underground without the use of ground stabilization techniques. The intent of the process is to minimize surface disruption and allow installation of pipe without many of the constraints imposed by trenching or conventional tunneling methods.

808.2 MATERIALS

- a) **Pipe** - Carrier pipe shall conform to the Supplemental Specification for Jacking Pipe of the size, type, materials, thickness and class indicated.
- b) **Grout** - Grout for voids shall consist of 1 part Portland Cement and 4 parts fine, clean sand mixed with water.

808.3 EQUIPMENT

General:

The microtunneling system shall consist of five major, independently controlled components:

- a) Microtunnel Boring Machine (MTBM)
- b) Jacking system
- c) Spoil removal system
- d) Guidance and control system
- e) Pipe lubrication system.

Description of the System:

- a) The Contractor shall provide a microtunneling system for installing pipe behind a remotely controlled, steerable, guided, articulated Microtunnel Boring Machine (MTBM). The MTBM shall be connected to and followed by the pipe which is installed by jacking and shall be capable of fully controlling the rate at which the material is being excavated at all times.
- b) The minimum depth of cover to the pipe being installed using the microtunneling process is normally six (6) feet or 1.5 times the outer diameter of the pipe being installed, whichever is the greater. With special precautions, and approval by the Engineer, this depth of cover may be decreased.

- c) Microtunneling work shall be executed so as to minimize settlement or heave. Overcut shall not exceed 1" on the radius of the pipe being installed without the approval of the Engineer. The annular space created by the overcut may be filled with the lubrication material that is used to reduce the friction drag of the soil on the pipe.

Micro Tunnel Boring Machine (MTBM):

- a) The MTBM shall be capable of controlling rotation or roll by means of bi-directional drive on the cutter head or by the use of fins or grippers. The MTBM shall be articulated to enable remotely controlled steering of the shield.
- b) A display showing the position of the shield in relation to a design reference shall be available to the operator at an operation console together with other information such as face pressure, roll, pitch, steering attitude and valve positions.
- c) The MTBM shall have a cutter face capable of supporting the full excavated area at all times, and may have the capability of setting a calculated earth balancing pressure and positively measuring the earth pressure at the face.
- d) When soil conditions dictate, the tunnel shall be capable of removing cobbles and boulders. The excavation system shall be fully capable of excavating all material that it will encounter.

Automated Spoil Transportation:

- a) The automated spoil transportation system shall match the excavation rate to the rate of spoil removal, maintaining settlement or heave within tolerances specified herein.
- b) The balancing of ground water pressures shall be achieved by the use of a slurry pressure or auger earth pressure balance system. The system shall be capable of any adjustment required to maintain face stability for the particular soil condition to be encountered on the project. The system shall monitor and continuously balance the ground water pressure.
- c) If a slurry spoil transportation system is used, the ground water pressure may be managed by use of the slurry pumps (which may be of variable speeds), pressure control valves and a flow meter. A slurry bypass unit shall be included in the system to allow the direction of flow to be changed and isolated, as necessary.
- d) A separation process shall be provided when using the slurry transportation system. The process shall be designed to provide adequate separation of the spoil from the slurry so that the clean slurry can be returned to the cutting head for reuse. The Contractor shall identify the type of separation process to be used.

If an Auger spoil transportation system is utilized, the ground water pressures may be managed by controlling the volume of spoil removal with respect to the advance rate (Earth Pressure Balance Method) and the application of compressed air. In soils with excessive ground water, approval of the Engineer may be required for earth pressure balance auger systems. Approval will be based on the evaluation of the equipments ability to balance soil and water pressures at the face, stability of the soils and the significance of the ground water present.

Pipe Jacking Equipment:

- a) The main jacks shall be mounted in a jacking frame and located in the drive (starting) shaft. The jacking frame successively pushes the MTBM followed by a string of connected pipes toward a receiving shaft. The jacking capacity of the system shall be sufficient to push the MTBM and the string of pipes thorough the ground.
- b) The main jacking equipment installed shall have a capacity greater than the anticipated jacking load. The hydraulic cylinder extension rate shall be synchronized with the excavation rate of the MTBM, which is determined by the soil conditions.
- c) Intermediate jacking stations shall be provided by the Contractor when the total anticipated jacking force needed to complete the installation exceeds the designed maximum jacking force of the pipe or 80% of the capacity of the main jacks.
- d) The jacking system shall develop a uniform distribution of jacking forces on the end of the pipe by the use of spreader rings and packing.

Pipe Lubrication System:

A pipe lubrication system may be utilized when anticipate jacking forces on the pipe are expected to exceed the capacity of the main jacks or exceed the pipe design strength with the appropriate safety factor. An approved lubricant shall be injected at the rear of the MTBM and, if necessary, through the pipe walls to lower the friction developed on the surface of the pipe during jacking and thereby reduce the jacking forces.

Remote Control System:

- a) A Remote Control System shall be provided that allows for the operation of the system without the need for personnel to enter the microtunnel.
- b) In man entry sized pipes, intermittent entry of personnel will be permitted into the pipe for maintenance during the drive and for removal of equipment once the pipe installation is complete.
- c) The control equipment shall integrate the method of excavation and removal of soil and its simultaneous replacement by the pipe. As each pipe section is jacked forward, the control system shall synchronize excavation and jacking speeds. The system shall provide complete and adequate ground support at all times.

Active Direction Control:

- a) Line and grade shall be controlled by a guidance system that relates the actual position of the MTBM to a design reference (e.g. by a laser beam transmitted from the jacking shaft along the center line of the pipe to a target mounted in the shield). The microtunneling system shall be capable of maintaining grade to within plus or minus 1" and alignment to within plus or minus 1.5", unless otherwise approved by the Engineer.
- b) The active steering information shall be monitored and transmitted to the operation console. The minimum steering information available to the operator on the control console shall include the position relative to the design reference, roll, indication, attitude, rate of advance, installed length, thrust force, and cutter head torque.

808.4 CONSTRUCTION METHODS

General:

The Contractor shall provide and maintain adequate microtunneling equipment, install support systems as required, provide and install carrier pipe, and faithful execution of work using microtunneling and installing pipe simultaneously. The Contractor shall have sole responsibility for safety of microtunneling operations and for persons engaged in the work.

The Contractor shall furnish shop drawings showing his proposed method of microtunneling, including design for microtunneling head, installation of microtunneling supports or back stop, arrangement and position of microtunneling machinery, pipe guides, grouting plan, intended disposal of excavated material, and a project safety plan for the Engineer's review.

Jacking and Receiving Shafts:

Shafts shall be of a size commensurate with safe working practices. The Contractor shall provide shop drawings showing the shaft locations for approval by the Engineer.

The design of the shafts shall ensure safe exit from the driving shaft and entry into the receiving shaft of the MTBM.

Shafts and jacking pit shall be adequately ventilated. Air monitoring of the shafts or pits shall be conducted by the Contractor on a continuous basis in accordance with the Contractor's Safety Plan.

Before beginning construction at any location, the Contractor must adequately protect existing structures, utilities, trees, shrubs and other permanent objects where visible or shown on the drawings.

The Contractor shall furnish and install equipment to keep the jacking shaft free of excess water. The Contractor shall also provide surface protection during the period of construction to ensure that surface runoff does not enter the driving shaft.

A thrust block is required to transfer jacking loads into the soil. The thrust block shall be designed to support the maximum jacking pressure developed by the main jacking system. Special care shall be taken when setting pipe guide rails in the jacking shaft to ensure correctness of the alignment, grade, and stability. If a concrete thrust block or treated soil zone is utilized to transfer jacking loads into the soil, the MTBM is not to be jacked until the concrete or other material have attained the required strength.

During construction operations and until pits are backfilled, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained conforming to the Manual Uniform Traffic Control Devices (MUTCD).

When grade of pipe at microtunneling end is below ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the microtunneling operations and for joining pipe. Work shall be sheeted securely and braced to prevent earth caving and to provide a safe and stable work area. Minor lateral or vertical variations in final position of pipe from line and grade established by Engineer will be permitted at the discretion of Engineer provided that such variations shall be regular and only in one direction and that final grade of flow line shall be in direction indicated.

If trench bottom is unstable or excessively wet or when installation of water and wastewater pipe will result in cover less than six (6) feet or 1.5 times the outer diameter of the pipe being installed, whichever is the greater, the Contractor shall notify the Engineer. The Engineer may require the Contractor to install a concrete seal, cradle, cap or encasement or other appropriate action.

As soon as possible after carrier pipe(s) are completed, pits or trenches excavated to facilitate these operations shall be backfilled. The backfill in the street ROW shall be compacted to not less than 95 percent of the density conforming to ASTM D698. At the Contractor's option, flowable excavatable fill may be used up to three feet below the finished surface grade.

Where the characteristics of soil or size of proposed pipe would make use of tunneling more satisfactory than microtunneling, a tunneling method may be submitted for acceptance by Engineer. Tunneling shall conform to the requirements of the Standard Specifications.

Jacking Pipe:

In general, pipe used for jacking shall be round, have a smooth, even outer surface, and with joints that allow for easy connections between pipes. Pipe ends shall be square and smooth so that jacking loads are evenly distributed around the entire pipe joint, such that point loads are minimized when the pipe is jacked. Pipe used for pipe jacking shall be capable of withstanding all forces that will be imposed by the process of installation, as well as the final in place loading conditions. The driving ends of the pipe and intermediate joints shall be protected against damage as specified by the manufacturer. The detailed method proposed to cushion and distribute the jacking forces shall be described by the Contractor for each particular pipe material.

Pipe showing signs of failure may be required to be jacked through to the reception shaft and removed. Other methods of repairing the damaged conduit may be used, as recommended by the manufacturer and subject to approval by the Engineer. Repair or replacement of damaged pipe shall be performed by the Contractor at no additional cost to the City.

The pipe manufacturer's design jacking loads shall not be exceeded during the installation process. The pipe shall be designed to take full account of all temporary installation loads. Jacking pipe is specified in other supplemental Specifications.

Installation:

Suitable pits or trenches shall be excavated for the purpose of conducting the jacking operations and for placing end joints of the pipe. Such work shall be sheeted securely and braced in a manner to prevent earth caving and to provide a safe, stable work area.

The microtunneling shall proceed from a pit provided for the microtunneling equipment and workmen. The location of the pit shall meet the approval of the Engineer. Excavated material shall be removed from the working pit and disposed of properly. The use of water or other fluids in connection with the boring operation will be permitted only to the extent to lubricate cuttings. Jetting shall not be permitted.

In unstable soil formations, water or processed drilling fluid, containing colloidal material such as bentonite, may be used to consolidate the drill cuttings, seal the walls or the hole and furnish lubrication to facilitate removal of the cuttings from the bore. Water jetting shall not be permitted.

808.5 SUBMITTALS

The following material shall be submitted by the Contractor to the Engineer for review:

- a) Manufacturer's literature describing in detail the microtunneling system to be used. Detailed description of projects on which this system has been successfully used.
- b) Method of spoil disposal.
- c) Anticipated jacking loads.

- d) Method(s) of controlling ground water at shafts and by the MTBM.
- e) Shaft dimensions, locations, surface construction, profile, depth, method of excavation, shoring bracing and thrust block design.
- f) Verification that the pipe complies with the project specifications.

This shall include literature describing the microtunneling pipe to be used on this project. The literature shall include allowable safe jacking loads with a safety factor of at least 2.5. A list of names, addresses, and telephone numbers of contacts on successfully completed microtunneling projects shall be provided for verification.

- g) Proposed shaft locations and sizes.
- h) Project Safety Plan.

All contractor submittals requiring structural design shall be signed and sealed by a Registered Professional Engineer in Kansas.